QUARTERLY BULLETIN No. 6

SEPTEMBER, 1954

Issued by

SULPHUR EXPLORATION SYNDICATE
35 PORTLAND PLACE
LONDON, W.1.

Telephone: MUSeum 8497
Telegrams: SULFEX, WESDO, LONDON

I N D E X

	Page
FOREWORD & REVIEW	1
UNION OF SOUTH AFRICA	5
PERU	17
PRICES & TRENDS	23
UNITED STATES SULPHUR	26
LEVIATHAN SULPHUR MINE	28
SULPHUR IN ITALY	30
AUSTRALIA	32
SULPHUR IN CANADA	34
RECOVERED SULPHUR IN THE MAN MADE FIBRES INDUSTRY	36
UNITED KINGDOM SULPHUR	37
THE LANGUEDOCIENNE PROCESS	40
THE LURGI WET CONTACT PROCESS	44
NORWAY - PYRITES	46
CURRENT EVENTS	48
U.K. - Sulphur recovery at A.I.O.C. Grangemouth refinery	48
Sulphur recovery at Shell Oil refinery, Stanlow	49
France - New sulphur prices	50
Recovered sulphur prospects	52
Turkey - Potential sulphur recovery from oil	52
Israel - Fertiliser & Chemicals Ltd.	53
U.S.A. - Standard Sulphur Co.	54
New dome exploration company	55
Texas Gulf Sulphur Company	56
American Sulphur & Refining Company	56
Sulphur recovery from oil	58
Mexico - Mexican Gulf Sulphur Company	58
Pan-American Sulphur Company	59
Chile - Exploitation prospects	59
STATISTICAL APPENDIX	60

F O R E W O R D

To permit easy reference to contents of earlier Bulletins a comprehensive index has been compiled and is issued together with this, the 6th, issue of the Quarterly Bulletin.

September, 1954.

R E V I E W

The sulphur industry of the UNION OF SOUTH AFRICA, the Commonwealth country reviewed in this Bulletin, is at present undergoing considerable expansion. The programme of uranium extraction from gold ore residues, initiated in 1950, created a need for nearly one half million tons sulphuric acid which is being met by seven new sulphuric acid plants. All but one obtain their sulphur requirements in the form of pyrites concentrates, which are produced as a sequel to the uranium extraction process. Whereas pyrites, present in gold ore in widely disseminated state, were not economically recoverable on a large scale, the integration of this process with uranium extraction made this not only possible but attractive. The non-uranium section of the sulphur industry consumes at present 105,000 tons sulphur, of which 85,000 tons is in the form of imported brimstone. By 1955 the increasing needs of the sulphuric acid industry and the "regular" sulphur users are expected to total 150,000 tons per annum sulphur, which together with the requirements for uranium production will raise the sulphur consumption in the Union to about 325,000 tons per annum. Of this tonnage over 70% is to be provided from indigenous sources and the balance by brimstone imports, representing an almost exact reversal of the present supply position.

The sulphur deposits of PERU, although not as extensive as those of Chile, are an important part of world reserves of native sulphur. Primitive mining methods and uneconomic refining facilities result in an output of only a few thousand tons annually. Not generally competitive in world markets, it finds an outlet in South American countries and partly meets domestic requirements which are confined to the use of "regular" sulphur. Part of Peru's sulphuric acid requirements are now met in by-product smelter acid, but the construction of a brimstone contact plant is in hand and a

further by-product acid plant is planned. The installation of modern sulphur mining and refining facilities, which are a prerequisite to the fuller usage of the country's sulphur wealth, is at present under consideration by U.S.A. interests. Although the expansion of domestic sulphur using industries is planned, foreign investment in Peru's sulphur industry will depend on its ability to compete in export markets.

In the UNITED STATES OF AMERICA production during the second quarter of 1954 of native and recovered sulphur continued at the high level of the preceding period and amounted to 1,458,192 tons. Thus, output during the first half-year was over 10% higher than during the corresponding period of 1953. As a result of increased apparent domestic and export demand in the second quarter totalling 1,499,503 tons, there was a moderate reduction of stocks although at end June these were still about 200,000 tons higher than at the beginning of the year. Although apparent domestic sulphur consumption in the first half-year was about 14¾% lower than in the first half of 1953, it is believed that consumers' stocks were substantially reduced, and that the drop of actual sulphur use was only about 5%, primarily due to the lower industrial activity in the steel and rayon industries. At the same time, sulphur exports rose to a record level corresponding to an annual rate of 1½ million tons.

The successful exploitation by ANACONDA COPPER MINING CORPORATION of the Leviathan Sulphur Mine, a low grade sulphur deposit in Nevada, and the direct use of the crude material in large scale sulphuric acid manufacture, provide a useful pointer for the economic development of other sulphur ore deposits where similar special conditions, permitting integration of the production cycle, obtain.

Although the earlier threat of closure of all sulphur mines in ITALY was avoided by timely government intervention, the present position remains indecisive. Restricted output by major mines and the closure by the Ente Zolfi Italiani of some of the most uneconomic mines which, in the case of the latter, has led to labour troubles has, for the present, reduced production approximately to the level of domestic requirements. The industry now awaits a lead from the Government which, it is expected, will either entail subsidising the industry to make it competitive in world markets, or will restrict its activities to home market needs.

The consumption of sulphur in all forms in AUSTRALIA during the fertiliser year 1953/54 amounted to 271,000 tons, the highest on record, resulting also in peak output of sulphuric acid and superphosphates. Adequate supplies of imported brimstone were reflected in slightly lower consumption of indigenous pyrites, although it is probable that pyrites use may rise again if the recommendations of the Tariff Board in respect of the Sulphur Bounty, payable to producers of acid from indigenous sulphur raw materials, enable them to compete with consumers of imported brimstone.

Sulphur production in CANADA in 1953 suffered a severe setback as a result of much reduced shipments of by-product pyrites from Quebec caused by prolonged strikes. Increased use of sulphur in smelter gases and recovery of sulphur from natural gas partly off-set this, and resulted in a total output of 352,168 short tons, 18½% less than in 1952. New projects to yield sulphur from pyrites and natural gas promise to increase Canada's sulphur output by nearly 70,000 tons per annum from the autumn of 1954 onwards.

The findings of the Chemical Products Committee of the ORGANIZATION FOR EUROPEAN ECONOMIC COOPERATION offer little prospect of increased sulphur saving in the rayon industry, with the possible exception of improved recovery in staple fibre manufacture. In the recently issued report by the same agency on the Sulphurous Raw Materials Position in 1953, an increase of 6% in sulphur production and consumption during the second half-year is indicated and the developments since 1949 are reviewed. Relevant data are shown in the Statistical Appendix.

In the UNITED KINGDOM consumption of sulphur in all forms during the second quarter 1954 amounted to about 210,000 tons, 14% more than during the corresponding period of 1953. Elemental sulphur consumption totalled 91,100 tons, 2½% less than during the first quarter, but in view of comparatively greater reduction in the use of pyrites and spent oxide for acid making, the proportion of brimstone acid rose fractionally to 35%. Total acid output amounted to 512,200 tons, 13½% more than during the second quarter of 1953. Acid consumption declined seasonally after mid-May. The total of 504,800 tons was 9½% greater than that during the corresponding period of 1953, with increases taking place in most sections of the industry. The only major decrease is recorded in the use for superphosphate manufacture.

The slight upsurge of the proportion of brimstone acid production in the second quarter was fortuitous, and not the result of a deliberate act of policy concerning the balancing factor. The possibility of this trend continuing cannot, however, be ruled out with plentiful low cost brimstone supplies coming forward and present actual production costs of brimstone acid 20% - 28% lower than those of pyrites acid.

The REFINING PROCESS developed by Societe de Languedocienne de Recherches et d'Exploitations Minieres is described in this issue of the Bulletin. Although specially designed to treat the impure, low grade ores of Malvezy, it is suitable for all types of sedimentary and volcanic sulphur ores. It entails flotation of ore to yield a concentrate of at least 70% sulphur, which is then refined by a process of gangue agglomeration. There is also a description of the wet contact process developed by Lurgi Gesellschaft für Chemie und Hüttenwesen m.b.H., for the recovery of sulphur in the form of sulphuric acid from coke oven gases.

The pyrites industry of NORWAY increased its output in 1953 to nearly $\frac{3}{4}$ million tons, the highest level since before the war. The expansion was primarily due to the rapidly increasing output at the Skorovas mine of Electrokemisk A.B., which had started production late in 1952. Norway's pyrites exports, of which about one third are directed to Iron Curtain countries, receded only about $4\frac{1}{4}$% compared with 1952, the smallest reduction suffered by any European pyrites exporter in 1953.

During recent months world market prices of sulphur have shown a slight downward tendency, and ample American Frasch supplies have comfortably met domestic and export demand. The successful start of production at the Jaltipan dome and continued satisfactory output at San Cristobal dome virtually assure that in 1955 about $\frac{1}{2}$ million tons of Mexican sulphur will seek export markets. Offers to date are competitive with U.S. sulphur. This proof of availability of Mexican supplies allays previous misgivings of a tightening situation at the close of this year. Offers of Chilean sulphur at near competitive prices are failing to find buyers, but a severe price cut has permitted sales from the Italian sulphur stockpile to start. With ample low cost sulphur supplies in sight the world sulphur markets promise to enter a period of competition.

U N I O N O F S O U T H A F R I C A [+]

General

The following survey of the sulphur industry in the Union of South Africa is presented at a time when this industry is in the midst of a considerable expansion programme. Its planning commenced about 1950, and it is expected to be completed before the end of 1955. The programme, encompassing the erection of eight sulphuric acid plants, and numerous other installations to supply their raw material needs, will eventually add roughly 600,000 tons per annum of new acid capacity to that of 270,000 tons which existed only a short while ago.

This large and rapid increase stems, principally, from South Africa's entry into the field of uranium production, the strategic metal being recovered as a by-product to gold mining in the form of its oxide (U_3O_8). In the process employed, large quantities of sulphuric acid are used to leach it from residual slime of gold ore, which also contains the pyrites required for production of the acid.

Prior to the expansion occasioned by the uranium developments about 71% of the available sulphuric acid capacity was based on the use of imported brimstone, and the balance on pyrites, pyrrhotite and spent oxide. By 1955 this position is expected to be reversed with brimstone acid capacity accounting for less than 30% of the available total. The uranium industry apart, consumption of sulphur in all forms, at present, amounts to about 105,000 tons, of which about 85,000 tons is in the form of imported brimstone. By 1955 the requirements of the non-uranium sector of the sulphur industry are expected to increase to about 150,000 tons, so that the total requirements of the Union may amount to about 325,000 tons sulphur per annum.

The size of the established sulphur industry is determined by the sulphuric acid requirements of the fertiliser industry. This accounts, at present, for 84% of the end-use of sulphuric acid - hitherto exclusively used for superphosphate manufacture - and it is of interest that a large proportion of the sulphuric acid so consumed is in the form of spent acid, which had previously been used in commercial

[+] All details of quantity are shown in short tons of 2,000 lb. Additional statistics are shown in the Appendix.

explosives manufacture. The expansion of agriculture, which at present contributes 15% of the Union's national income and employs 47% of the country's gainfully employed labour force, and the consequent increasing use of fertilisers will inevitably lead to greater sulphur needs. The expected rapid growth of secondary industries, notably chemical, textiles and the metallurgical, may however significantly influence future trends and bring about a wider diversification of end uses of sulphur and sulphuric acid.

Production

The Union of South Africa lacks deposits of native sulphur. Its sulphur resources are in the form of pyrites disseminated in gold ore and coal, pyrrhotite associated with copper ores and a variety of metal sulphides, notably copper, zinc, antimony, copper-lead and copper-nickel-platinum. In addition small quantities of spent oxide result from town gas purification. Other potential sources of recovered sulphur are coke oven gases, petroleum refining and oil-from-coal production.

Pyrites and Pyrrhotite

During the past 25-30 years, the gold mining company, West Rand Consolidated Mines Ltd., has been the only large and consistent producer of pyrite, which it recovers from its gold ore by a process of jigging. In addition, other minor pyrite producers have contributed small quantities from time to time. These are the smaller gold mines situated at Barberton, Sabie and Graskop in the Eastern Transvaal, and the tin producer, The Rooiberg Minerals Development Company Ltd., north of Pretoria. Lastly, the O'Okiep Copper Company at Nababeep separates pyrrhotite from its mined copper ores.

Combined annual output from these sources ranged from 34,000 - 45,000 tons pyrite concentrates (40% - 45% sulphur content) in past years. There have, however, been considerable local developments in this field since early 1953. In order to satisfy the vastly increased demand created by the establishment of the seven new pyrite-based acid plants, a further five mines were selected to become producers. They are as follows:-

Daggafontein Mines Ltd.
Vogelstruisbult Gold Mining Areas Ltd.
Government Gold Mining Areas (Modderfonetin) Consolidated Ltd.
Western Reefs Exploration & Development Company Ltd.
Virginia Orange Free State Gold Mining Company Ltd.

Of these Daggafontein commenced operations early in 1953; Western Reefs followed in the third quarter of that year, and Government Gold Mining Areas have very recently come into production. The remaining two flotation plants are scheduled to produce before the end of the current year.

The following graph shows total production of pyrite concentrates in the Union reflecting the rapid increase in output that has taken place in the past 18 months:-

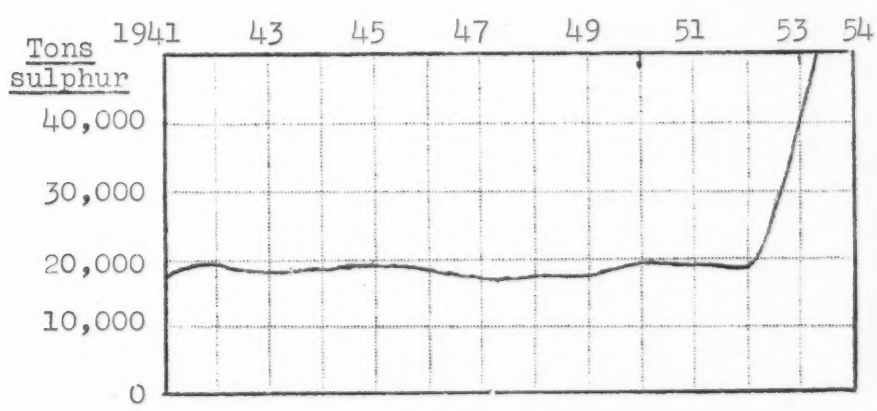


Fig. I

+ Production during first half 1954 totalled 38,406 tons sulphur in pyrites.

The output capacity of the new plants is not known. It is expected that ultimately all requirements for both uranium and non-uranium purposes, totalling about 600,000 tons pyrite concentrates (42% - 43% S) annually within the next year or two, will be met from indigenous sources.

While pyrite occurs in practically all gold mines, the percentage present varies from a figure rarely exceeding

3.0 down to 0.5 or less. No published information is available on this matter, but the indications are that the majority of mines probably contain less than 2% by weight of pyrite. At the present world price of elemental sulphur, recovery is seldom economically attractive.

The filter cake obtained after the removal of gold by cyanide treatment of gold ores was formerly dumped, still containing uranium and other gangue materials, including pyrite. To recover uranium the filter cake is now treated with dilute sulphuric acid, and after filtering and the removal of the solid residue, the uranium bearing solution is purified and by the use of chemical reagents, uranium oxide is precipitated from it.

The residue which remains after the acid has dissolved the uranium in the slime, is taken to a flotation plant, where the iron pyrites are removed in the form of a concentrate and taken by conveyor belt either direct to the sulphuric acid plant for roasting in fluo-solid reactors, or to stockpiles.

Metal Sulphides

It has been estimated that yearly production of the various metal sulphides could yield the equivalent of well over 50,000 tons of sulphur. At present, however, none of this sulphur is used locally for conversion to acid. Approximately half of the production is exported for extraction of the metal overseas. In general, the balance is available at such scattered localities, far removed from the larger industrial centres, and in insufficient quantities at any one site to justify the erection of plant to process the gases evolved.

Spent Oxide and Coke Oven Gases

Spent oxide, resulting from the purification of town gas prepared by carbonising coal, is produced by gas works at Johannesburg, Cape Town, Port Elizabeth, Grahamstown and Springs. Total annual production approximates to 400 tons sulphur equivalent in a product which is worked up to contain a minimum of 40% sulphur.

An estimated quantity of 3,000 tons of sulphur could

be extracted from coke oven gas at the various installations possessing the necessary by-product units. No provision for such recovery has, however, been made to date.

Other potential sources

Perhaps the most important potential source of recovered sulphur is the oil-from-coal project of the South African Coal, Oil and Gas Corporation Ltd. (SASOL). In the course of converting coal into a wide range of petroleum products an annual quantity of about 10,000 tons hydrogen sulphide is expected to arise. For the time being this will be exhausted in the atmosphere after being diluted about 100-times with carbon dioxide and air. At the recently erected crude oil refinery of the Standard-Vacuum Refining Company of South Africa (Pty.) Ltd. at Durban, and the South African Torbanite Mining and Refining Company Ltd., Boksburg, Transvaal, recovery of sulphur and/or sulphuric acid would also be possible. It is estimated that these three sources could yield the equivalent of at least 10,000 tons sulphur annually.

Consumption

The following graph depicts actual and anticipated consumption of sulphur in all forms during the period 1948-56.

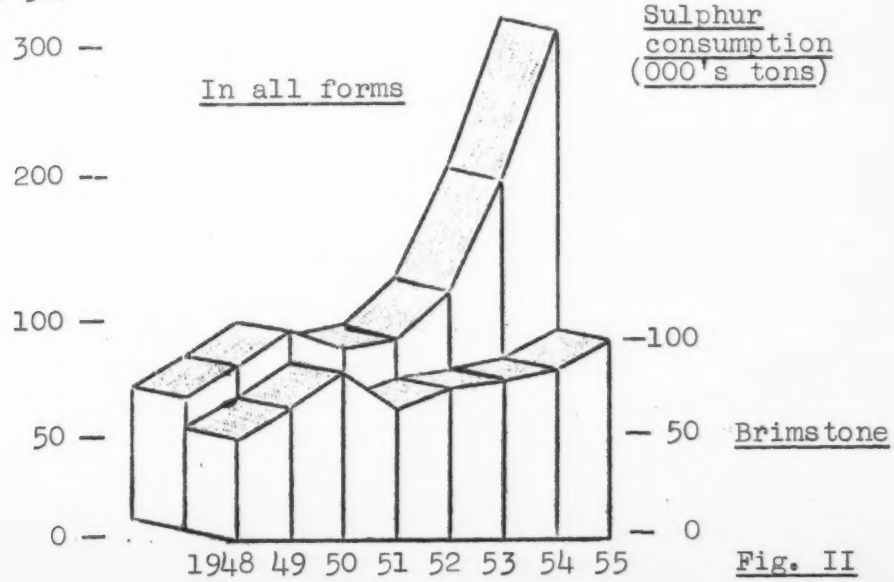


Fig. II

Consumption of sulphur for "regular" uses has increased during the above mentioned period from about 9,000 tons per annum. At present the distribution by consuming industries is approximately as follows:-

Sugar refining	6,500	tons
Agricultural uses (dusts, sprays, dips)	3,500	"
Rubber industry	900	"
Other (chemicals, pharmaceuticals, paper, matches, & fireworks, etc.)	200	"
	11,100	tons

The Union possesses its own sulphur refining facilities, so that generally less than 10% of the estimated annual consumption of 4,000 - 4,500 tons of the refined grade is imported.

Sulphuric acid

In the non-uranium section of the industry there are at present two companies operating four sulphuric acid plants. Those of Messrs African Explosives and Chemical Industries Ltd., are located at -

Somerset West (near Cape Town) - sulphur-burning contact plant.

140 000 tpa acid 440 000 tpa pyrites

Umbogintwini (near Durban) 15 m. S of - sulphur-burning contact and pyrite lead-chamber plants.

Modderfontein (near Johannesburg) - pyrite contact plant.

Messrs O'Okiep Copper Company Ltd., Nababeep, in the N.W. Cape Province, roast pyrrhotite for their chamber acid plant.

The combined nominal capacity of these plants is about 270,000 tons acid (100% H_2SO_4), of which some 78,000 tons, or 29%, are based on sulphurous raw materials such as pyrites, pyrrhotite, spent oxide, and the balance of 71% on elemental sulphur. Contact acid capacity accounts for 80% of the total.

However, a degree of flexibility exists in as far as capacity and the use of alternative raw materials are concerned. Output of acid can be raised to a yearly total of close on 300,000 tons; and by the expedient of converting one of three pyrite-roasting units to sulphur burning at one of the localities, shortages of pyrite have, in the past, been partly overcome.

At Umbogintwini a new pyrite-roasting installation, with a Petersen tower plant, has been under construction for the past year, and is expected to reach the production stage by mid-1955. This addition will swell acid producing capacity by about 140,000 tons per annum. However, as the existing lead chamber units at this location are of fairly old construction, their future function may be more in the nature of a stand-by. Even if these units are demolished eventually, the development at Umbogintwini represents a net gain in acid capacity of just on 100,000 tons a year.

As regards the programme for uranium acid production seven plants, sited at strategic points, have been planned. They are:

x Daggafontein Mines Ltd.
x West Rand Consolidated Mines Ltd.
x The Randfontein Estates Gold Mining Company (Witwatersrand) Ltd.
x Western Reefs Exploration & Development Company Ltd.
Stilfontein Gold Mining Company Ltd.
Virginia Orange Free State Gold Mining Company Ltd.
Blyvooruitzicht Gold Mining Company Ltd.

Six of these plants are based on pyrite, while the seventh will use elemental sulphur. Four plants (x) are already producing, a further two will start shortly, and the remaining one during next year. First of these sulphuric acid units to commence production was that of West Rand Consolidated Mines Ltd., officially opened on 8th October, 1952. This, incidentally, was the first installation in the world to combine the fluo-solids roasting of pyrite with a contact sulphuric acid plant, and five similar contact units are already in existence or being erected at other localities.

The individual capacities of the plants have not been

disclosed. In a recent statement by a leading mining personality closelyassociated with this industry, however, it was revealed that combined output would total about 40,000 tons sulphuric acid a month.

It appears, therefore, that total productive capacity in the Union, by the end of 1955, will have been trebled from the 1952 figure of 270,000 - 300,000 tons acid to about 900,000 tons.

Production of acid:

Production in 1953 amounted to just on 245,000 tons acid (100% H_2SO_4), excluding the quantity manufactured in the plants of the gold mines, for which no statistics are available.

This represents the first year of normal production after the restrictions imposed on the industry by the international sulphur shortage of 1951 and 1952. The year was, furthermore, characterised by a slackening of demand for superphosphate, necessitating a corresponding reduction in output.

In 1954, acid output is expected to increase to about 262,000 tons, for which the following raw materials are required:-

Elemental sulphur	73,600	tons
Sulphur in pyrite & pyrrhotite	19,500	"
Sulphur in spent oxide	500	"
	93,600	tons

Consumption of acid:

The following table shows the expected consumption of acid by principal uses in 1954:

	tons	
Superphosphate	220,000	84.0%
Metallurgical uses	22,000	8.4%
Other (chemicals, lead-acid batteries, textiles, insecticides)	20,000	7.6%
Total	262,000	100.0%

As the table indicates, the primary requirement of acid is for the production of 19.5% P_2O_5 superphosphate. Two factories, at Somerset West and Umbogintwini, owned by Messrs African Explosives and Chemical Industries Ltd., have an output of between 650,000 - 700,000 tons annually. By virtue of its importance as a sulphuric acid consumer, the fertiliser industry and its products, therefore, assume a dominant role in determining the trend of acid production each year.

These circumstances enabled South Africa to cut down on sulphur consumption and to weather the international shortage of brimstone that existed a few years ago. During this period, production of a ground rock phosphate/superphosphate mixture was reverted to for the manufacture of which much less acid was needed. Agriculture was issued with approximately the same volume of phosphatic fertiliser as in previous years which, while containing a smaller percentage of immediately available P_2O_5, was not less in total content of the oxide. Thus, in 1952, total acid production dropped to 234,000 tons, of which 188,000 tons entered into the manufacture of superphosphate, resulting in a saving of more than 10,000 tons of elemental sulphur normally required for acid production. In 1953, production of the straight superphosphate was recommenced.

In this connexion it might be mentioned that all rock phosphate required for conversion to the acid soluble form has in past years been wholly imported, mainly from the traditional source - Morocco. One local deposit provides about 10% of requirements, in the form of rock phosphate not suitable for acid treatment. Now, however, a government sponsored company - Phosphate Development Corporation (Pty.) Ltd., - is erecting the necessary plant at the site of a low-grade phosphatic deposit at Phalaborwa in the North East Transvaal with the object of beneficiating the ore from a content of 10% P_2O_5 to 33% - 35%, for ultimate conversion to superphosphate. The initial plant, scheduled to commence operations early in 1955, will at first be capable of satisfying only a fraction of the Union's present needs, but is to be extended further in the light of the results achieved. A recent survey has shown the existence of much larger reserves than were originally suspected, and it is confidently held that this source will eventually cater for the Union's total requirements for a considerable period.

In addition to the gradual expansion of superphosphate manufacture, the acid requirements of the fertiliser industry are shortly expected to increase by about 25,000 tons per annum when the arising of by-product ammonia at the oil-from-coal project of SASOL will permit the annual production of 35,000 tons ammonium sulphate.

This new source of nitrogen for fertiliser manufacture is a welcome addition to the nitrogen capacity which became available this year by the three-fold expansion of existing nitrogen-fixation plant, and which provided the first locally produced nitrogen fertilisers. Hitherto the output of 25,000 tons per annum ammonia from atmospheric nitrogen and coke oven gas was wholly consumed in explosives manufacture at Somerset West and Modderfontein, which are probably the largest commercial explosive factories in the world. Although they are large users of concentrated acid, this is only used as a dehydrating agent and becomes available as spent acid to be used at Somerset West for superphosphate manufacture, whereas from Modderfontein it is disposed of to industries in and near Johannesburg.

The acid plant at Nababeep is attached to a copper mine where total production is used to leach oxide copper ores.

There are no imports of acid in bulk into the Union, and about a thousand tons leave the country for neighbouring territories.

Acid consumption for uranium ore treatment is increasing rapidly, but no statistics are available. Since productive capacity is said to have been aligned to demand for uranium recovery, with no surplus available for other industrial purposes, it must be assumed that ultimate consumption will be in the region of 480,000 tons a year.

Imports

The following graph shows imports of elemental sulphur (crude and flowers) during the period 1939-53:

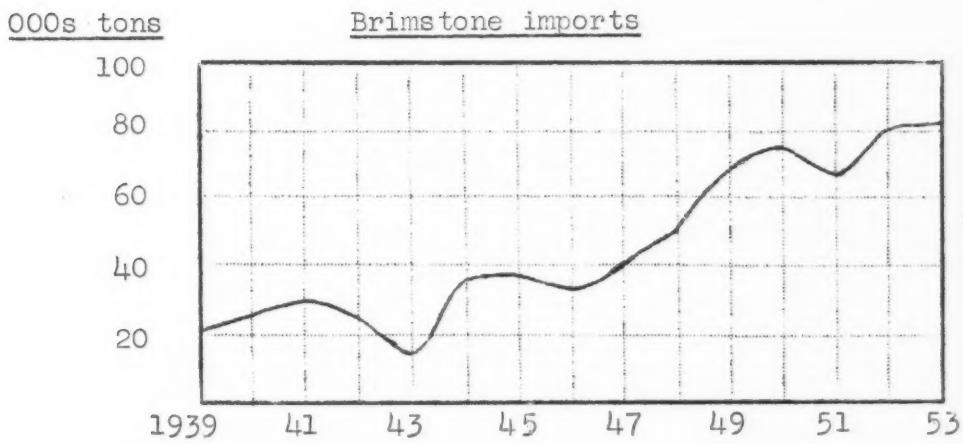


Fig. III

The bulk of these imported supplies originates in the U.S.A. During the war the Union experienced considerable difficulties in obtaining adequate brimstone supplies as indicated in the low import figure of 1943. After the war the favourable aspects of elemental sulphur use rapidly increased import requirements, particularly from 1949 onwards, when a new sulphur burning acid plant was commissioned. The present level of sulphur imports is expected to increase slightly by 1955 and become stabilised for a number of years at about 100,000 tons per annum. In addition to elemental sulphur the Union also imports sulphur in pyrites concentrates. These originate from the Iron Duke mine of the Broken Hill Development Company at Glendale, Southern Rhodesia. During the sulphur shortage in 1951/52 the Union imported 6,000 - 7,000 tons concentrates in each year. In spite of the recent large increase in production, imports in 1953 amounted to over 32,000 tons concentrates.

Prices

Imported American sulphur is at present landed in the Union at about £14 - £14.10s. per ton.

Prior to the start of pyrites production in connexion with the uranium ore treatment the value of sulphur in indigenous pyrites had been comparatively stable over many years; from about £3.10s. f.o.r. mine per short ton sulphur in 1949, it had increased to £3.17s. in 1952. A substantially increased output in 1953, however, was valued at £6 per ton sulphur, and during the first quarter of 1954 it had further advanced to £6.10s.

Conclusion

The spectacular expansion of sulphur production in the Union by the integrated recovery from gold ore residues of uranium oxide and pyrites represents perhaps the most outstanding example of utilising on large scale a source of sulphur supply which, purely from a sulphur point of view, would not have permitted economic exploitation. At the same time it is significant that the established sulphuric acid industry of the country continues to rely mainly on imported brimstone, since the economic advantages of this form of sulphur supply outweigh the desirability of complete self-sufficiency.

Although in this sector of the country's sulphur industry and in the use of "regular" sulphur a 50% increase in consumption is indicated over the next 2-3 years, further rapid growth is probable as the present industrial structure, which is essentially based on primary industries, is expanded by the more intensive development of secondary industries. The scope of the Industrial Development Corporation which has already led to government participation in iron and steel (ISCOR)+, chemicals (KOP)+, phosphate rock (FOSKOR)+, oil from coal (SASOL)+, and rayon pulp (SAICCOR)+, will undoubtedly play an important part in this.

Developments to date indicate that by 1956, total sulphur requirements of the Union of South Africa may amount to about 325,000 tons, of which about 70% would be met in the form of indigenous by-product pyrites. The potential recovery of sulphur from oil refinery and coal hydrogenation gases holds promise of an even greater degree of self-sufficiency, although the expansion of industrial activity is unlikely to permit a quantitative reduction of brimstone imports.

+ Full titles are as follows:-

South African Iron and Steel Industrial Corporation.
Klipfontein Organic Products Corporation Ltd.
Phosphate Development Corporation (Pty.) Ltd.
South African Coal, Oil and Gas Corporation Ltd.
South African Industrial Cellulose Corporation.

We are indebted to the Secretary for Commerce and Industry, Pretoria, for the detailed information placed at our disposal.

P E R U

General

Situated on volcanic peaks of the Andes, the bulk of the sulphur deposits of Peru have the same general characteristics as those in Chile. In fact, the principal deposits in the southern part of Peru are merely a northward continuation of the Chilean chain. The occurrence of such volcanic sulphur deposits is not as extensive as in Chile, and with one or two exceptions the deposits are appreciably smaller.

The Peruvian deposits are, however, favoured by their occurring at lower altitudes (12,000 - 14,000 ft.), by better climatic conditions, by abundant water supplies in the area of deposits, and by early promise of an easement of transport difficulties. The last named factor which is one of the principal reasons for the high f.o.b. cost of Chilean sulphur, may be resolved by an extensive road construction programme which is to be expedited to permit the movement of a wide range of other minerals to Ilo, the principal seaport serving this mining region. At present a substantial volume of mineral traffic is moved by rail to the Chilean port of Arica, which is a free port for Peruvian goods and commodities.

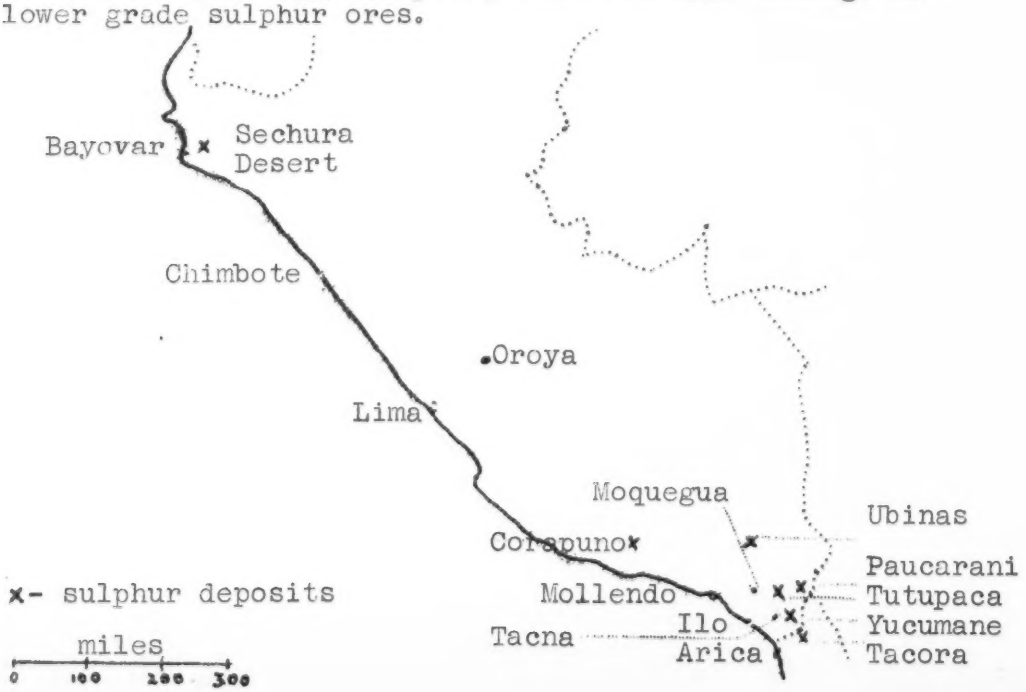
Sulphur mining in Peru appears to have been carried on as far back as the 17th century. As an industry sulphur production was started in 1934 by Cia Explotadora Paucarani, but notwithstanding other mining enterprises entering the field total Peruvian production has rarely exceeded 2,500 tons per annum. Production methods have remained unchanged; mining is carried on by manual labour and sulphur refining by retort distillation or in autoclaves. In 1952 an attempt was made at one mine to replace these uneconomic processes when, by capital investment from aborad, the Tutupaca sulphur mine was to have been modernised and sulphur refining to have been carried out by a solvent extraction process. This project failed, but there are at present indications that investment by U.S.A. interests may introduce modern mining and refining methods with a view to producing competitive sulphur for export, and to meet domestic requirements which are expected to rise. At present the latter amount to 2,000 - 3,000 tons elemental sulphur per annum, of which

more than half has to be imported as the required qualities are not being produced locally.

Plans exist for the establishment of sulphuric acid, fertiliser, nitrogen fixation, ammonium synthesis, alkali, and artificial textile plants. The Peruvian Government is at present putting into effect currency stabilisation plans, and the accompanying cutting back of public investment expenditure is likely to postpone the realisation of these developments. The achievement of a favourable trade balance and a strengthened internal economy, which these measures are intended to bring about, may attract foreign investment capital which, amongst others, would benefit the sulphur industry of Peru.

Deposits and Production

There are no authoritative details available on the country's total sulphur reserves. Various estimates by mining companies and claims by promoters indicate the existence of some 25 million tons of caliche, with an average content of 40% - 50% sulphur, and a similar tonnage of lower grade sulphur ores.



The largest known individual sulphur deposits are located in southern Peru, mainly in the departments of Tacna and Moquegua, and these provide the bulk of current sulphur output.

Cia Azufrera Peruana Ltd.

This company, in which Imperial Chemical Industries Ltd. have an interest, operates a mine situated at Yucumane in the Cano region. Current indications of reserves are about 3 million tons of good quality caliche. Refining is in four autoclaves which have a combined annual capacity of 6,000 tons. Plans to double the refining capacity were forestalled by the return of normal world trading conditions and prices. From Yucumane the finished product is transported by road to Tacna, whence it is railed to Arica.

Cia Azufrera Tutupaca

The sulphur deposit exploited by this company is covered by six concessions on the extinct Tutupaca volcano. It is believed that its reserves, estimated to amount to about 11½ million tons of mineral containing average 50% sulphur, are the largest in the country. Conventional mining and refining methods permit an annual production of 3,500 tons sulphur which is transported by road 56 miles to Ilo.

During the sulphur crisis of 1951/52 this company was acquired by Canadian and Mexican interests, assisted by some British capital, and it was intended to modernise mining operations and install the Nagelvoort carbon disulphide solvent process for refining sulphur, permitting the production of 18,000 tons per annum refined sulphur. Lack of experience and irresponsible management resulted in financial difficulties before the plant was even installed, and the project folded up.

Cia Explotadora Paucarani

This company exploits the deposits situated in the chimney of the extinct Caparaja volcano on the eastern flank of the Cordillera Barroso. Estimated reserves are about 5½ million tons of sulphur ore containing 40% - 90% sulphur. The high grade material occurs in pockets as a result of solfataric emanations. Ore refining is effected by old fashioned retort distillation permitting an annual

output of up to 2,500 tons sulphur. Heavy fuel costs in recent years, reduced annual output to a few hundred tons only. Distribution of the company's production is through Arica.

Other sulphur deposits which are being worked intermittently are concessions, north and north-west of the Chilean Tacora mines, operated by the Azufrera de Pachia at Quenuta situated 15 miles west of the Arica-La Paz railway. On the west side of the Cordillera Barroso there are a number of sulphur deposits which have been superficially surveyed, but not worked. For these and similar deposits in the Tacna Province mining claims were filed during the 1951/52 boom with a view to attracting capital for exploitation. This applies also to the sulphur deposits situated further north on the Corapuno volcano north of Chuquibamba, which is about 150 miles N.W. of the port of Mollendo, and to the deposits on the Ubinas volcano in the Chimbote area.

Apart from these volcanic sulphur deposits there are sedimentary deposits in northern Peru in the Sechura desert. These were formed by the reduction of gypsum in tertiary layers by organic matter such as oil and petroleum gases, which in this region come to the surface in big seepages. The resulting sulphur has impregnated the overlying sands and this process appears to be continuing. About 50 years ago an attempt was made to exploit these deposits and a railway was built to Bayovar, and a shipping pier was built on the coast. This enterprise failed, however, completely and the railway was abandoned. In 1952 Texas Gulf Sulphur were test drilling this deposit, but they did not pursue the project.

The following graph shows sulphur production in Peru for the years

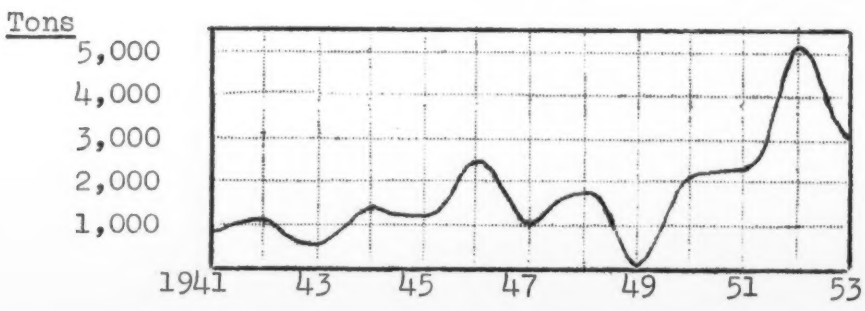


Fig. IV

The most significant new development in Peru is the proposed exploitation of volcanic sulphur deposits in southern Peru by a subsidiary of the Fluor Corporation of Los Angeles, Fluor Peruana Ltd., which was established about twelve months ago with a view to assisting in the expansion of Peru's mineral, chemical and oil industries. In the sulphur field it is intended to introduce modern mining methods and to install refineries at Arica and Ilo permitting large scale refined sulphur production. It is not known what process is to be used, but it is thought likely that one of the processes of the American Sulphur and Refining Company may finally be chosen (see also p. 56).

Consumption

Consumption of sulphur in all forms amounts to about 5,000 - 7,000 tons per annum. Of this quantity elemental sulphur accounts for about 2,000 - 3,000 tons, and the balance is used in the form of sulphuric acid. Agricultural uses and sugar refineries account for the entire elemental sulphur consumption which is in the form of refined/ground sulphur, and sulphur candles. As indigenous sources are unable to supply certain grades, about half of the country's elemental sulphur requirements are met by imports.

Sulphuric acid

The recovery of the sulphur content of smelter gases in the form of sulphuric acid is today perhaps the most important aspect of Peru's sulphur industry. The annual by-product acid output at the copper smelter of Cerro de Pasco Corporation at Oroya amounts to about 6,000 tons (equivalent to about 2,200 tons sulphur). Most of the production is captive, being consumed for ore leaching. In addition to the acid requirements of the mineral industry, there are various small industrial users, and total acid consumption amounts to 8,000 - 10,000 tons per annum. The balance of the acid requirements of 2,000 - 4,000 tons are at present imported, but on completion of the acid projects now in hand the need to import is expected to cease. The most advanced project is the acid plant now being built by the Pan-American Consulting Company, which will primarily supply the acid requirements of Peru's only rayon plant at Lima. In conjunction with the mining project at Chimbote, the Corporacion Peruana del Santa propose to erect a

sulphuric acid plant which will obtain its sulphur requirements from waste gases of the proposed zinc smelter. The detailed plans for this project were drawn up by the Westinghouse International Development Company, but the retrenchment of government expenditure is expected to delay their realisation.

Trade

Sulphur exports from Peru in recent years have been as follows (in metric tons):-

1947 - 775	1951 - 2830
1948 - 958	1952 - 4710
1949 - 244	1953 - 612
1950 - 96	1954(Jan.-June) - 1013

They are directed primarily to neighbouring South American countries such as Brazil and Argentina, although small quantities have also been exported to Finland and the U.K. (in 1954). Imports of refined sulphur originate principally in the U.S.A. These were as follows (in metric tons):

1949 - 817	1952 - 2714
1950 - 620	1953 - 2891
1951 - 646	1954(Jan.-June) - 800

In October, 1953, an important modification to import tariff rates was made permitting all sulphur imported into Peru for agricultural purposes to come in duty free, provided that the material met a minimum specification of 96% sulphur passing 325 mesh.

Summary

The large-scale economic exploitation of Peruvian sulphur reserves depends, in the same was as in neighbouring sulphur ore producing countries, on the introduction of efficient mining and refining methods.

The Peruvian Government is said to favour the development of the country's sulphur wealth ostensibly on the grounds that the planned development of chemical and textile industries will lead to a substantial increase of domestic sulphur requirements. It is thought, however, that these developments are likely to be slow. Moreover, although Peru

is essentially an agricultural country, with over 80% of its population so employed, there is at present little need for an artificial fertiliser industry - normally the largest sulphur user in a country's economy - as Peru's fertiliser requirements are mainly met by guano supplies collected from islands off its shores. Thus it would appear that large scale sulphur production would have to depend on export markets, and there is little doubt that the project of Fluor Peruana, which is to come into operation within the next 18 months will only be realised if its output can prove competitive in world markets.

PRICES AND TRENDS

Prices

During the past three months there has been a slight downward trend in the world price structure. The U.S. export prices for bright sulphur have remained unchanged at $31 (Texas Gulf Sulphur, Freeport Sulphur, Duval Sulphur & Potash companies) and $33 (Jefferson Lake Sulphur and Standard Sulphur companies) per ton f.o.b. Gulf ports. A significant change has been the increase by Freeport Sulphur Company of the discount for off-colour sulphur which, as from 1st September, will amount to $1 - an increase of 50¢ - resulting in an export price for this grade of $30 per ton f.o.b. The discount for off-colour grades granted by Texas Gulf Sulphur Company remains at $1.50, corresponding to an export price of $29.50. Offers of Mexican sulphur for deliveries late this year or early next year have reached potential customers throughout the world, and prices are based on and are competitive with those of U.S. Frasch sulphur.

Early in September Ente Zolfi Italiani issued a new price list which shows a reduction of 33% below earlier levels. They are as follows:-

	Min. Purity	Price	
		Lire per m. ton	£ per l. ton
Gialla Superiore	99.5%	28.000	16. 5.0
Gialla Inferiore	99 %	27.600	16. 1.0
Buona Sicilia	98 %	26.000	15. 2.0
Corrente Sicilia	96 %	25.500	14.16.0

Notwithstanding the above official prices, important tonnages from the large stockpile have been offered at a level of about £11.10s. per ton f.o.b., which is at or near world prices.

With the exception of a quotation for a tender invited by the Argentine Government no offers of Japanese sulphur have been reported. The quotation for delivery to the Argentine is believed to be above world prices, and is thought to have been made in conjunction with other commercial transactions between the two countries.

Offers of parcels of Chilean sulphur of up to 10,000 tons have reached consumers in the U.K. and on the Continent at prices as low as $26 per metric ton f.o.b. Chilean port for minimum 99.3% sulphur, and $29.75 for minimum 99.5% material. No acceptances have been reported to date.

In August offers of small parcels of German recovered sulphur reached the market at £12 per ton f.o.b. Hamburg. There has been a slight reduction in the price of Norwegian sulphur which is now quoted at about £14 per ton f.o.b.

The following table shows a comparison of prices of sulphur of different origin. F.o.b. prices and freights are based on recent quotations.

	f.o.b. Country of origin	Freight+ to. U.K.	c.i.f. U.K.
United States	US $29.50 - $33	55/-	£13¼ - £14½
Mexico	- do -	60/-	£13½ - £14¾
Italy/Sicily	L.19,500-L.28,000	42/6	£13½ - £18⅜
Chile	US $26 - $29.75	80/-	£13½ - £14¾
Japan	US $38ø	82/6	£17¾
Ecuador	US $40	77/6	£18⅜
Canada	$20 ex works	80/-	£18⅜

+ Based on bulk cargoes of 5,000 - 6,000 tons on the usual sulphur terms of chartering.

ø Calculated on basis of earlier offers to Australia and India.

In view of the competitive entry into world markets of Mexican Frasch sulphur, substantial tonnages are likely to be on offer at prices slightly below U.S. levels. It is not, however, thought that this will lead to a general immediate lowering of American prices, but that a decisive stage may be reached about mid-1955 when actual availability of Mexican sulphur will probably have attained influential proportions.

The level of European pyrites prices has remained unchanged and as producers' commitments are generally to the end of a year no change is expected to take place. It is reported from several quarters that consumers are seeking lower prices for deliveries during 1955.

Supply

The continued high level of production of U.S. Frasch sulphur has comfortably met the increased domestic and export demand during the second quarter of 1954, with the result that producers' stocks increased. This tendency appears to have continued and has resulted in American producers actively seeking export business. During the spring and summer months U.S. exports were nearly 40% above the level of the corresponding period of 1953. In Mexico production at the San Cristobal dome of the Mexican Gulf Sulphur Company continued at a rate of about 100,000 tons per annum, most of which is accumulating in stockpiles ready for the start of export shipments in November. Production at the Jaltipan dome of Pan American Sulphur Company started at the end of September, slightly ahead of schedule. With the third producer, Gulf Sulphur Corporation, who hope to be in production in summer 1955, with an output of 150,000 tons per annum, it is now confidently expected that about ½ million tons Mexican Frasch sulphur will seek markets in 1955.

Sulphur production in Italy which, during the first six months of the year, amounted to about 99,500 tons, 9% less than during the corresponding period of 1953, has substantially declined in recent months, and is believed to amount to not more than 10,000 tons per month, approximately equal to domestic needs. With a view to liquidating the accumulated stockpile of ¼ million tons, the Ente Zolfi Italiani, as mentioned above, are offering at world prices and to date some 20,000 tons are believed to have been sold

to France. It is considered likely that further price reduction will be necessary to move larger tonnages. More than half of the above tonnage is in qualities lower than 99.5% sulphur.

Export shipments of Norwegian sulphur to Australia (9,000 tons), France (3,000 tons) and Spain (3,000 tons) having been completed earlier this year, the balance of production is earmarked for the normal Scandinavian market.

In Japan the supply position remains unchanged, with production aligned to the needs of the domestic market. The tender to the Argentine is believed to cover some 5,000 tons only which would virtually dispose of the planned export surplus for the year.

Production in Chile continues at a low level of about 30,000 tons per annum which, in addition to meeting domestic requirements, provides a moderate export tonnage to neighbouring countries. The above-mentioned supplies offered on world markets are believed to be partly old stock, the disposal of which would permit more intensive production at some of the larger mines.

The supply outlook for the remaining months of 1954 continues easy. The apparent realisation of Mexican supply prospects assures for the immediate future ample availabilities of low cost sulphur. This will inevitably stimulate short-term demand for elemental sulphur, but it will be necessary to re-establish consumers' confidence in the longer term security of supply before a swing back to predominant elemental sulphur use can take place.

UNITED STATES SULPHUR

Native Sulphur

During the second quarter of 1954 production of Frasch sulphur, continuing at a high level, amounted to 1,365,692 tons, which was 0.9% less than during the preceding quarter and 0.9% more than during the corresponding period of 1953. Total output during the first half year amounted to 2,743,940 tons, and was 4½% greater than in 1953.

Apparent sales during the second quarter were 1,402,016 tons, which represented an increase of over 240,000 tons (20¾%), compared with the preceding quarter. During the corresponding period in 1953 apparent sales were 5% greater, but this tonnage had been inflated by substantial purchases preceding the price rise on 1st June, 1953. Apparent sales for the first six months of 1954 of 2,563,912 tons were about 7½% lower than during the same period of 1953.

The increased level of apparent sales during the second quarter 1954 is partly attributable to high exports which amounted to 445,057 tons. Total exports during the first half year amounted to 749,401 tons compared with 597,787 tons in the first half of 1953.

Although stocks of Frasch sulphur decreased about 36,000 tons during the second quarter, the end June stocks of 3,202,514 tons were 180,000 tons greater than at 1st January.

Recovered sulphur

Production of sulphur recovered from natural and oil refinery gases during the second quarter 1954 amounted to 92,500 tons, the highest total on record in any quarter. This output is 7,500 tons (8¾%) greater than during the preceding quarter, and 5,800 tons (6%) greater than during the corresponding period of 1953. Apparent sales of recovered sulphur amounted to 97,487 tons, demand having risen progressively throughout the quarter in line with seasonal trends. As a result stocks at end June amounted to 126,575 tons, a reduction of about 5,000 tons.

The salient points in the development in the U.S. sulphur industry in the first half of 1954 are thought to be as follows:-

(a) Total production of native and recovered sulphur amounted to 2,921,440 tons, which corresponds to an annual rate of 6½% greater than in 1953.

(b) Apparent consumption of native and recovered sulphur amounted to 2,722,181 tons, which corresponds to an annual rate of 1½% less than in 1953. Whereas

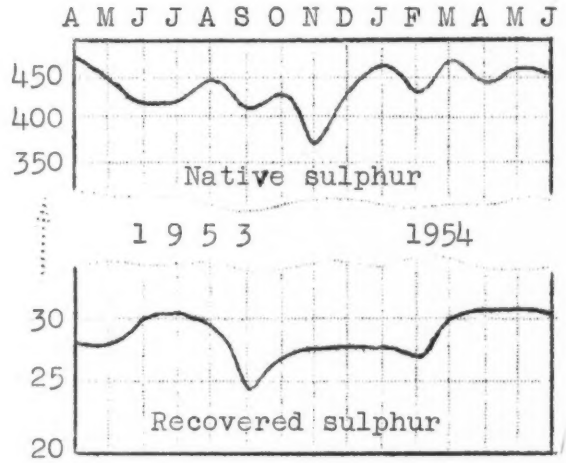
apparent domestic consumption appears to be about 14¾% lower than during the corresponding period during 1953, the actual reduction is thought to be in the region of 5%, with sulphuric acid output about 3½% lower and "regular" sulphur consumption about 9% lower. Sulphur exports were over 150,000 tons (25%) greater.

(c) Total stocks of native and recovered sulphur increased by 200,000 tons.

The above data do not take into account production of sulphur from mined ore. Prior to operations starting at Anaconda Copper Mining Company's Leviathan sulphur mine, mined ore provided only a negligible annual output of about 3,000 tons ore containing 20% - 30% sulphur. The new project which is described below will provide annually up to 65,000 tons sulphur in ore containing 25% - 30% sulphur. The entire output is captive in Anaconda's sulphuric acid operations.

Fig. V

MONTHLY PRODUCTION FIGURES 1953 to 1954



THE LEVIATHAN SULPHUR MINE

Since November 1953 large scale mining operations of low grade sulphur have contributed, at an annual rate of up to 65,000 tons sulphur, to the sulphur requirements of the U.S.A. This notable development was a corollary to an agreement concluded in 1951 between the Federal Government and the Anaconda Copper Mining Company requiring the latter

to bring into production the Yerington copper ore deposit,[+] and to develop its own sulphur supplies needed for large scale sulphuric acid production for copper ore leaching. This review is only concerned with the latter aspect of this outstanding project which required a total investment of close on $35 million.

The most significant features of the sulphur operation are the direct use for acid manufacture of low grade (25% - 30%) sulphur ore[*] and the first-time employment of fluo-solid roasters for this purpose. From the point of view of roasting techniques two new developments were achieved, namely, to dry feed fluo-solid reactors from the top and to effect satisfactory bottom discharge of the burnt residue. The Leviathan mine is worked by open-cast operation after a 200 foot overburden - some 19 m. tons - of altered volcanic rock had been removed. The ore body averages 25% sulphur in a gently dipping layer of up to 100 foot thickness. Sulphur occurs in elemental form impregnating much altered volcanic tuffs, agglomerates and adesites, with some iron sulphide also present.

To provide a minimum grade of 25% sulphur, ore mining is selective and constant control by a quick assay method was made possible by the simple nature of the ore. The annual requirements of ¼ million tons ore are obtained during the summer months when output is at a daily rate of 1,500 tons.

Mined ore is crushed on the site through a 4" grizzly and screened on a ⅛" screen. Under-size material is low grade and is discarded. The over-size is transported by road to the acid plant at Weed Heights near Yerington, some 60 miles distant, where it is stockpiled. Prior to roasting in Dorr type fluo-solid roasters, of which four are installed, ore is crushed in ⅞" cone crushers and ground to -14 mesh in rod mills. During these operations all dust is extracted by

[+] The copper ore deposit is estimated to contain 35 million tons oxide copper ore (0.97% Cu) underlain by a 15 million ton sulphide copper ore of similar grade.

[*] Note: In Bulletin No.4, p.22, it was erroneously stated that sulphur ore production would result in the output of 40,000 tons refined sulphur for acid manufacture.

multiclone dust collectors. The high (10% - 12%) moisture content of the ore caused handling difficulties which were resolved by dry feeding the ore on top of the reactor instead of the usual side feeding in the form of slurry. Bottom discharge of calcines permitted coarser grinding needing less exacting control. This innovation did not impair roasting conditions, nor were air requirements to maintain ideal suspension excessive.

With a 5" fluidised bed kept at a temperature of 1,200°C, and a 9 tons per hour feed, the reaction time is about 5½ hours. Gas yield from three reactors at full capacity is 32,000 cu.ft. per minute of 8% - 12% sulphur dioxide. Theoretically 18% SO_2 concentration can be obtained. Before passing to the acid plant, SO_2 laden gases are cooled and scrubbed in a series of cyclones to remove dust particles. The calcines from the reactor contain only .06% sulphur, and the dust from the cyclone assays .09% sulphur. Conversion takes place in a two-stage contact plant built by Chemical Construction Company. It has a rated capacity of 450 tons per day (100% H_2SO_4) and is sufficiently flexible to permit efficient operation at lower production rates.

Without in any way detracting from the important achievement of utilising this source of elemental sulphur in an economically viable large scale production cycle, it should be remembered that the proximity of mine to roasting plant, and the integration of ore production with what is one of the largest acid plants in the world, have contributed significantly to the success of the project. It would, therefore, not be practicable to draw more than superficial conclusions. Nevertheless, under similar special conditions, direct utilisation of low grade ores appears to be attractive.

SULPHUR IN ITALY

Since the government intervention early in August[+] which averted a threatened closure of all Sicilian sulphur mines, production has been continued but on a reduced scale.

[+] See Newsletter 5th August, 1954.

The immediate difficulties of the Ente Zolfi Italiani were alleviated by the government authorisation to raise a further loan of one billion lire (£572,000) to pay interest charges on sulphur stocks, and to permit payment - as from 1st July - of a subsidy of 6,000 - 8,000 lire per ton of sulphur produced. This subsidy appears to bring producers' revenue up to the authorised level. Previously the payment against delivery into warehouse was approximately 80% and, due to its inadequacy to meet costs, led to the threatened closure of mines.

Pending the passage in the House of Representatives of the three bills which the Minister of Industry promised to table, and any directives to the industry that the Government may feel obliged to issue, there is considerable anxiety and uncertainty throughout the industry. It is thought in many quarters that the only course that may provide a solution would be the reduction of Italian output to a level commensurate with domestic consumption which does not depend on world price levels. The alternative - competitive exports - is believed to be only attainable if the Italian Government authorised a substantial subsidy or agreed to preferential export rates.

With the approval of the Italian Government the Ente Zolfi Italiani started early in September to dispose of the accumulated stocks which are being offered at or near world market prices. It is believed that the difference between book value and the realised price is to be borne by the Government.

The new Board of the Ente Zolfi Italiani, which assumed office on 8th July, consists of the following personalities:-

Chairman	Dott. Ing. Francesco Lanza di Scalea
Managing Director	Dott. Rag. Francesco Palma (Palma Squibb Co.)
Directors	Dott. Guiseppe La Barbera (Banco di Sicilia)
	Conte Dott. Carlo Faina (Montecatini)
	Comm. Corso Caponi of SAIM, Naples (Irpinia mines)

Representing Sicilian mine owners	Ferdinando Morillo, Barone di Trabonella Rag. Pietro Vinciguerra Contessa Laura Perrier Pintacuda
Secretary to the Board	Avv. Antonino Cartellet
Trade Union representatives	Rag. Aldo Nicosia Dott. Spartaco Lanza

The Chairman is a descendant of an old distinguished and noble Sicilian family. It is also reported that Professor Gerbella who had, for many years, been in charge of the technical direction of the Italian sulphur industry, has resigned his appointment and that Ing. Raffaele Lauri has relieved him.

The present reduction in the level of sulphur production came as a result of an Ente Zolfi Italiani request to the major producers to cut back individual output, and by the slight acceleration of the proposed programme of reconstruction which provided for the closure of the most uneconomic mines. In several instances this has led to sit down strikes, some of which have now been going on for over two months, and it is reported that in recent days other miners have come out in sympathy. It is as yet too early to say whether this will lead to major labour unrest in the Sicilian sulphur industry.

AUSTRALIA

During the fertiliser year ending 30th June, 1954, consumption of sulphur in all forms amounted to about 271,000 tons, the highest on record. Sulphuric acid production amounted to 734,000 tons and was 105,000 tons (16.9%) higher than during the preceding year. Consumption of the various raw materials for acid manufacture was as follows:-

	Tons	
	1953/54	1952/53
Sulphur	146,368	113,763
Pyrites	146,171	149,567
Zinc concentrates	146,145	141,646
Spent oxide	11,927	12,351

a) Cap Woolnough area
b) A.C.F. & Shirleys — subsidiary of ? Australia Fert Ltd who subsidiary of ICI ANZ
Fabs have plant at Pinkenba, Qld.

Consumption of sulphur for "regular" uses of 7,660 tons was fractionally lower than in the previous year, but in view of the higher brimstone consumption for acid production, total elemental sulphur consumption of 154,028 tons was 26¾% higher than in the previous year.

During the year 1954/55 even higher levels of production are expected since new acid plants at Albany,[a] Western Australia, Cairns,[b] Northern Queensland, and Rum Jungle, Northern Territories, are expected to be in operation by December of this year. The last mentioned plant is believed to have started operations on 17th September, when Mr Menzies, Prime Minister of Australia, inaugurated the uranium oxide concentrating plant. During 1955 the new contact acid plant of Sulphuric Acid Ltd., which will operate on Nairne pyrrhotite concentrates is expected to be in production. At the Port Pirie plant of Broken Hill Associated Smelters Ltd., the completion of the new sinter plant is expected to result in partial discontinuation of brimstone use as the contact acid plant will consume sulphur in lead smelter gases.

In view of adequate brimstone supplies, the consumption of pyrites did not expand as had been expected. It is reported that substantial tonnages of pyrites, bought under long-term contract are accumulating in stockpiles at consumers' works in Victoria and New South Wales.

The output at the new contact acid plants of Electrolytic Zinc Company as Risdon, and Broken Hill Associated Smelters Ltd. at Port Pirie, Sulphide Corporation at Cockle Creek, raised the tonnage of contact acid by over 74,000 tons to 190,800 tons, which represents 26% of the total acid production. The increase of acid output, of which over 90% is used for fertiliser manufacture, is reflected in the record output of superphosphate, amounting to 1,771,300 tons, 12% higher than during the preceding year.

Although the quantitative allocation of brimstone remains under control of the Federal Government, ample world sulphur supplies are expected to permit consumers' requirements being met in full.

At the recently concluded Tariff Board hearing regarding the payment of a bounty on sulphuric acid produced from Australian raw materials, the evidence of all witnesses was

unanimous that such a bounty should be paid in order to permit production costs to be brought into line with those for brimstone acid. The finding of the Board and details of the subsidy procedure are expected to be made public in the near future.

SULPHUR IN CANADA

Sulphur production in Canada during 1953 amounted to 352,168 tons+, compared with 432,720 tons in 1952ø. This represents a decrease of 18½%, which was mainly due to a severe reduction in the amount of by-product pyrites shipped by the major producers of western Quebec because of prolonged strikes during 1953. The following table shows production of sulphur in various forms during 1952 and 1953.

Production	1953	1952
	Tons	
Sulphur in pyrites	143,722	263,241
Sulphur in smelter gases	190,151	160,547
Sulphur recovered from natural gas	18,295	8,932
	352,168	432,720

Apparent consumption amounted to 581,665 tons, or about 68,000 tons (10½%) lower than in the previous year, taking into account exports of sulphur in pyrites of 129,608 tons (197,897 in 1952) and imports of American sulphur of 359,105 (415,185 in 1952). It is believed, however, that about 30,000 tons sulphur in pyrites were drawn from consumers' stockpiles and taken into consumption.

Sulphuric acid production in 1953 amounted to 820,000 tons, fractionally more than in the previous year, but due to higher exports of 47,900 tons apparent consumption was slightly lower.

+ All details of quantity in this review are given in short tons of 2,000 lb.

ø 1952 production figures shown are amended and differ in several respects from the preliminary data included in the survey in Bulletin No.2.

As shown above the utilisation of sulphur in smelter gases rose substantially as the expansion projects of Canadian Industries Ltd. and the Aluminium Company of Canada settled down to regular production. It will be recalled that Canadian Industries Ltd. utilise waste gases of the International Nickel Company's smelter for the manufacture of sulphuric acid and liquid sulphur dioxide. The Aluminium Company of Canada produce sulphuric acid from sulphur dioxide in smelter gases arising in the course of zinc concentrate roasting by Barvue Mines Ltd. In the last quarter of 1953 Consolidated Mining and Smelting Company started operations at their new phosphatic fertiliser plant at Kimberley. The sulphur requirements of the sulphuric acid plant are met from by-product pyrrhotite concentrates which, when the plant is in full production, are to be consumed at an annual rate of 110,000 tons.

During the year Noranda Mines Ltd. started construction of their new pyrites treatment plant adjoining the fertiliser plant of North American Cyanamid Ltd. at Port Robinson. It was reported recently that this plant is due to come on stream in October, 1954. Processing of by-product pyrites at an annual rate of 120,000 tons is expected to yield 18,000 tons of elemental sulphur, 36,000 tons of sulphur as sulphur dioxide and 72,000 tons iron sinter.

The Shell Oil Company's decision to expand their sulphur recovery plant at the Jumping Pound natural gas field was an important development in increasing Canadian sulphur supplies from this source. As reported in Bulletin No.4, the additional supplies are to meet the sulphur needs of the acid plant of Gunnar Gold Mines Ltd., who work an important uranium property in the Lake Athabasca area. The extension work is expected to be completed in the late autumn of 1954, resulting in an increase of sulphur production capacity from 32 to 80 tons per day.

In view of the low prices obtainable for sulphur in pyrites, production remained confined to producers of by-product material. Ex mine prices rose about $1 to $3.50 - $4 per long ton pyrites, but the average value of pyrites exports declined from $8.31 per ton of sulphur in pyrites to $7.99 in 1953. Lower transportation charges masked to some extent the increase of American Frasch sulphur which was delivered to consumers in eastern Canada at prices between $35 - $45 per long ton.

RECOVERED SULPHUR IN THE MAN MADE FIBRES INDUSTRY

The Chemical Products Committee of the Organisation for European Economic Cooperation has recently published the results of its investigations into the possibility of increasing sulphur recovery in the man made fibres industry.

The report includes the following points:

(1) Recovery from ventilation gases

The recovery of hydrogen sulphide and carbon disulphide from ventilation gases is not economic and therefore confined to removing the proportion of injurious products in the waste gases in excess of the legal limits.

(2) Recovery of carbon disulphide from viscose filament

Whereas the centrifuge ("box spun") and "continuous spinning" processes do not offer means of recovering carbon disulphide from the filament, the parallel ("bobbin spun") process permits recovery of up to 45%. The hot water treatment necessary to effect this can often cause alteration of the quality of the filament, and consequently it is not widely used. In the present stage of rayon filament manufacturing techniques it does not, therefore, seem possible to expect any substantial recovery of sulphur, although experiments continue regarding the continuous spinning process which is comparatively new.

(3) Recovery of carbon disulphide from staple fibre

In certain plants about 40% of sulphur used can at present be recovered as CS_2. The report considers that this proportion could be raised in sound economic conditions to 50% compared with a technically possible figure of 65%. On the other hand, it points out that there is a risk in certain cases that the hot water treatment required, may impair the quality of the fibre. As a result, some staple

fibre mills are not equipped for recovery, although the producers are continuing extensive research to evolve a more satisfactory process.

(4) Recovery of sulphur in sulphuric acid

The amount of sulphuric acid saved by evaporation and crystallisation is already near the possible maximum that can be expected from the manufacturing processes used. The resultant arising of crystallised sodium sulphate, however, presents a major problem of conversion to a readily marketable product. The Committee hoped that research into suitable processes and utilisation might be investigated by the European Production Agency, but it is reported that the Agency would only consider such a proposal if the industry provided the necessary funds.

The man made fibres industry in O.E.E.C. countries in 1952 consumed some 170,000 tons of carbon disulphide, and 680,000 tons acid (100% H_2SO_4), representing about 300,000 tons sulphur. Consumption in 1953 is estimated to have been about 40% greater.

From the above conclusions it would appear that, pending the solution of the useful disposal of sodium sulphate, a further saving of sulphur is only likely by improved recovery of carbon disulphide in staple fibre manufacture; in 1952 about 26%, or 30,000 tons was recovered by Member Countries. An increase depends, however, not only on raising the proportion in mills already equipped for recovery, but on the development of methods which will not affect the quality of the staple fibre which some producers clearly consider a risk in the present processes and therefore as a limitation on their usefulness.

UNITED KINGDOM SULPHUR

During the second quarter of 1954 consumption of sulphur in all forms amounted to about 210,000 tons, or about 2¼% less than during the preceding quarter, but still 14%

higher than during the corresponding period of 1953. It is estimated that, of the above total consumption, 33% was met from indigenous sources (sulphur in spent oxide, anhydrite, zinc smelter gases and recovered from oil refinery gases) 27¾% in the form of imported pyrites and 39¼% in the form of imported brimstone. Actual imports amounted to 75,724 tons brimstone at £13.4s.6d. per ton, and 150,518 tons pyrites at £7 per ton. With the exception of sulphur in zinc smelter gases consumption of the various raw materials was lower than during the preceding quarter. Details are as follows:-

	2nd Qtr 1954	1st Qtr 1954	Change+	2nd Qtr 1953	Change+
Sulphur					
acid	63700	64500	-1¼%	61800	+3%
regular	27400	28800	-4¾%	21700	+26¼%
Total	91100	93300	-2¼%	83500	+9%
Pyrites	124000	130300	-4¾%	95900	+29¼%
Spent Oxide	71700	76800	-6¾%	68700	+4½%
Zinc con.	54000	49100	+10%	40000	+35%
Anhydrite	43900	44700	-1¾%	45900	-4%

+ Percentage figures shown indicate change between earlier periods and second quarter 1954.

Monthly consumption figures of raw materials were as follows:-

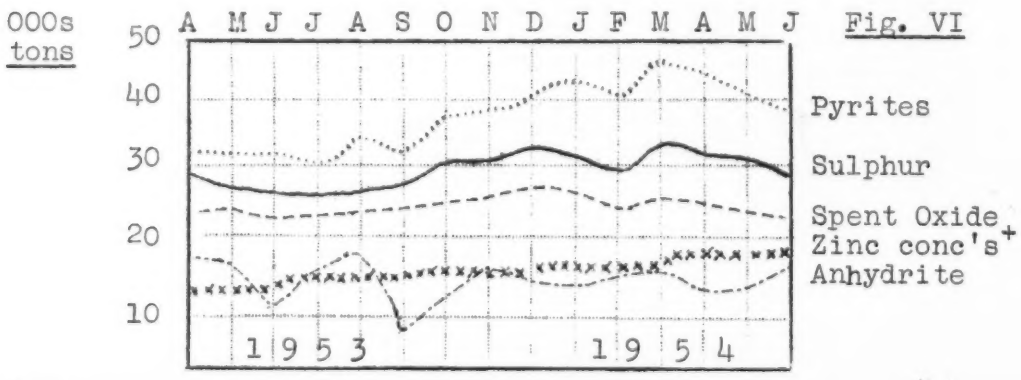


Fig. VI

+ Note: graph based on quarterly data.

Sulphuric acid

Production during the second quarter amounted to 512,200 tons (100% H_2SO_4). This output was 2¾% less than during the preceding quarter but 13½% higher than during the corresponding period of 1953.

Acid production resulted from the use of sulphur bearing raw materials in the following proportions:-

	2nd Qtr 1954 %	1st Qtr 1954 %	~~1st~~ Qtr 1953 %
Sulphur	35	34¾	38½
Sulphur in pyrites	32	32¼	27½
Sulphur in spent oxide	19	19¾	20½
Sulphur in zinc smelter gases	9	8¼	8
Sulphur in anhydrite	5	5	5½

During the second quarter total available acid making capacity amounted to 592,350 tons, of which 86.5% was utilised. During this period additional new capacity of about 35,000 tons per annum contact acid became available. Contact acid production amounted to 351,400 tons, which accounted for 68% of total acid output. Employment of sulphur burning capacity remained virtually unchanged at about 75%, while that of pyrites roasters and spent oxide burners decreased to an estimated level of about 85% and 92% respectively.

Consumption of sulphuric acid amounted to 504,800 tons, or about 5½% less than during the preceding quarter. The decline in acid consumption started after mid-May, mainly as a result of seasonal trends in the fertiliser industry. Compared with the corresponding period of 1953 acid consumption was 9½% greater and the principal changes by consuming industries were as follows:-

	Tons	Increase
Titanium oxide	+10,900	26½%
Dyestuffs	+ 4,900	31%
Iron pickling	+ 4,600	20%
Drugs & fine chemicals	+ 3,800	119%
Soap & detergents	+ 3,400	48%

Notable increases in acid consumption, though quantitatively smaller, were recorded for tar and benzol (+47%), bromine (+44%), lithopone (+32%), and plastics (+32%). The only significant decrease occurred in superphosphate manufacture where acid consumption was 7,800 tons (6½%) lower than the corresponding period of 1953.

Stocks

During the second quarter of 1954 sulphur stocks decreased slightly by 2,500 tons to 79,800 tons, which, at current rate of consumption, would meet demand for about 2½ months. Stocks of pyrites increased 23,500 tons to 169,400 tons representing over four months' consumption at current rates. Spent oxide stocks declined further to 150,800 tons, a decrease of nearly 8% during the quarter.

The most significant features of sulphur development during the second quarter are:-

(a) Continued high sulphur consumption at the rate of about 365,000 tons per annum.

(b) The reduction of the share of imported sulphur in total consumption to below 40% for the first time since before the war.

(c) The fractional increase in the proportion of brimstone acid production.

The possibility of this trend continuing cannot be ruled out, in view of the economic advantage of brimstone acid production. Under comparable conditions current costs of raw materials, labour and overheads indicate that brimstone acid (100% H_2SO_4) is 20% - 28% cheaper to produce than pyrites acid, making full allowance for the value of pyrites residues and without taking into account plant amortisation. The continued availability of low-cost brimstone supplies, which appears to be assured for at least 18 months, is bound to exert a strong influence.

THE LANGUEDOCIENNE PROCESS

Developed by the Societe Languedocienne de Recherches et

d'Exploitations Minieres of 10, Avenue George V, Paris, this process was specially adapted to treat the low grade ores (8%S) of the extensive deposits of Malvezy, near Narbonne in south France, which this company has been exploiting since 1941. The process is based on enrichment by flotation of the crude low grade ore, followed by a process of gangue agglomeration and filtering of the molten flotation concentrate. The process is suitable for all sedimentary and volcanic sulphur ores, but is perhaps unique in its ability to treat effectively argillacious and bitumen contaminated low grade ores for which it was designed.

Operation

Ore preparation: From a stockpile, pre-crushed to -$\frac{3}{4}$" (80mm.), sulphur ore is screened, the over-size being passed through a hammer mill to yield -$\frac{5}{8}$" (15 mm.) material, which is then wet ground in two conical ball mills operating in closed circuit with one Akins Duplex classifier. The overflow from this classifier goes to the flotation conditioner and the fines to the conical regrind mill in closed circuit with two rake classifiers producing a material of -40 mesh.

Flotation: At the flotation conditioner pine and gas oil are added to the pulp, which is then subjected to the action of Denver No.30 "Sub A" flotation cells - in the case of the Narbonne plant four banks of ten cells with a total volume of 100 cu.m. (131 cu.yds). The resulting primary concentrate contains 40% - 50% sulphur, whereas the residual pulp is practically free from sulphur and is pumped to a slime pond. The primary concentrate is screened on a 60 mesh screen. The over-size is nearly pure sulphur which would not float in the cleaning cells, and it is passed directly to the concentrate thickener. The under-size is led to cleaning cells - the Narbonne plant has 43 with a total volume of 40 cu.m. (52$\frac{1}{2}$ cu.yds). Cleaning cell middlings are recirculated to the head of the primary circuit. The recleaned concentrate passes to the thickener (at Narbonne a 40 ft. Dorr type), and the under-flow is fed through a rotary drum filter. The final concentrate contains 75% - 80% sulphur, the highest concentrate obtainable from this type of ore, so that further purification is necessary.

Refining: The present method was evolved after the earlier process of filtration and subsequent crystallisation of the molten sulphur proved unsatisfactory, due to poor recovery since the high sulphur content of the residue (45% - 50%) could not be separated by flotation. In the present process gangue particles in the molten sulphur which had been heated to 120-130°C are agglomerated by the addition of a reagent under controlled temperature conditions and contact period, and, above all, with the molten sulphur strongly agitated. The agglomerating agent is cheap, non-corrosive, does not generate noxious fumes - thus permitting open-air processing - does not react with the chalky and argillacious gangue and is easily recoverable for reuse. After gangue agglomeration, the molten mass is screened on a plate perforated with 0.157" diameter holes. The under-size is high grade refined sulphur and the over-size is agglomerated gangue, which is subsequently washed to recover the reagent and returned to the flotation circuit to recover the low residual sulphur content. In view of the bitumenous nature of the ore, the refined sulphur is discoloured a dark brown. To eliminate this the sulphur is intimately mixed with bleaching clay which removes the organic disolouring matter. The dirty clay is filtered off and the final product is bright yellow, containing minimum 99.5% sulphur.

Recovery and plant capacity

The extent of recovery depends largely on the grade of flotation concentration that it will yield, and, to a small extent, on the type of ore. In the treatment of the low grade Malvezy ores which at best permit the production of a 80% sulphur concentrate, recoveries of up to 94% have been achieved. With better grade ores yielding a 90% concentrate recovery of 97.5% of the original sulphur content is normal.

The Narbonne plant has a capacity of about 25,000 tons refined sulphur per annum. The Languedocienne process is not, however, limited to a set capacity and the size of plant, the degree of its employment and the installation of individual sub-units is adaptable in the light of circumstances.

Material requirements and costs

The adverse nature of the Malvezy sulphur ore with

its argillacious gangue and extreme dissemination and fineness of a large proportion of the sulphur necessitates the use of large amounts of flotation reagents, and large quantities of water. The latter need arises in view of the impossibility of desliming, and pulp, prior to flotation, has to be much diluted to the extent of 250 g. ore to one litre water (2½ lb. to one gal. water). It is estimated that with an ore permitting the production of a concentrate containing 90% sulphur, the production costs per metric ton of refined sulphur from such a concentrate are approximately as follows:-

Production:	Labour	- 2 man-hours
	Electricity	- 45 kW hours
	Steam (at 14 kg. per sq.cm.)	- 0.9 m.ton
	Reagent & supplies	- fr.400(8s.,$1.15)
Maintenance:	Labour	- 0.7 man-hours
	Material	- fr.150(3s.,43¢)

The above data indicate basic production costs at about £2.10s. per ton refined sulphur, excluding amortisation. An installation (excluding cost of buildings) with a capacity of 2,000 tons per month refined sulphur, similar to that at Narbonne would require a capital investment of £80,000 - £100,000. The process royalties which are related to output of sulphur over a period, are low.

Application

At present the only plant utilising this process is the Societe Languedocienne's own plant at Narbonne. Due to excessive mining costs the production of refined sulphur from French ores is not at present economic as this product is unable to compete with imported American sulphur (see also p.52).

In view of its many outstanding features, the process has aroused much interest, notably in Italy, Greece, Japan and South America, and it is understood that a number of specific investigations are proceeding. At present, however, no definite plans for the erection of a plant embodying this process are in view.

THE LURGI WET CONTACT PROCESS

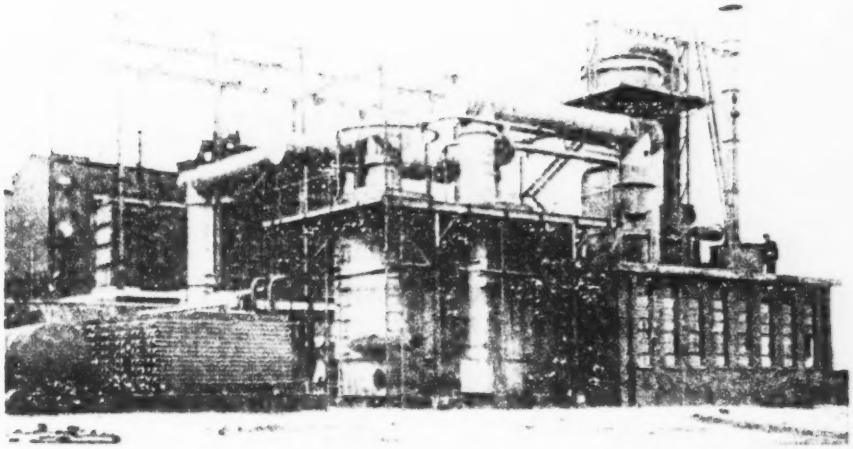
This process was developed by Lurgi Gesellschaft für Chemie und Hüttenwesen m.b.H., Frankfurt am Main, specifically for the recovery of sulphur in the form of sulphuric acid from coke oven gas.

Operation

In the course of washing out the ammonia from coke oven gas the small quantities of hydrogen sulphide contained in the gas are concentrated in the ammonium liquor. After the expulsion of the volatile constituents and the neutralisation of the ammonia with sulphuric acid, a gas escapes from the ammonium sulphate saturators containing 20% - 30% hydrogen sulphide apart from carbon dioxide and traces of ammonia, hydro-cyanic acid.

To convert this gas mixture into sulphuric acid, a modified contact acid process known as wet catalysis is carried through without previous drying of sulphur dioxide gases. The hydrogen sulphide leaves the ammonium sulphate saturator at a temperature of 98°C and must be freed from the excess water vapour by cooling prior to further treatment. The cooled gas is burnt in the furnace (1), lined with fire bricks, with such an amount of air as is required for the combustion of H_2S to SO_2 and for the oxidation of SO_2 to SO_3. In order to avoid contamination of the contact mass by dust, the air is previously cleaned in a filter (2). Where the concentration of the H_2S gas is too low, so that the heating value does not suffice to keep up the combustion, a corresponding amount of coke oven gas may be added to the gas. Before entering the converter (4) the SO_2 gas is cooled by radiation pipes (3) or in a waste heat boiler to about 450°C. The converter is built on the tray principle and contains several layers of vanadium contact mass, by means of which the oxidation of SO_2 to SO_3 is effected in the presence of air. In order to lead off the reaction heat generated during this process and to maintain the most favourable temperature, air is blown through the cooling jacket of the converter (5).

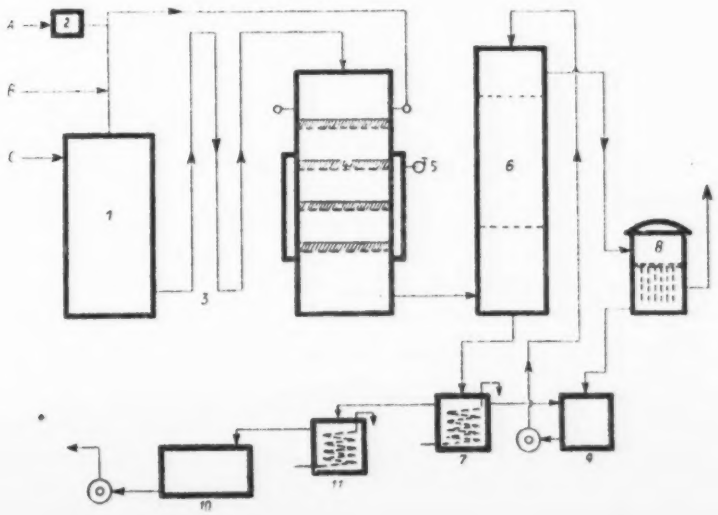
Subsequently the gas enters a spray tower (6) designed similar to a Glover tower. In this tower it is cooled by spraying with sulphuric acid, the main quantity



Wet Catalysis Plant at "Prosper" Coke Oven Works.

From left to right: production reservoir; spray coolers; two converters; absorption tower on platform; ceramic pressure filters; gas chimney.

Note: The hydrogen sulphide combustion furnace and the waste heat boiler are not shown in the picture.



of the SO_3 being absorbed as acid of 60°Bé while the remainder escapes in the form of acid mist. The acid draining from the tower is cooled in indirect coolers (7) sprayed with water. The unabsorbed acid mist is precipitated in a ceramic pressure filter (8) and led as acid of 60°Bé to the running tank (9) of the spray tower. When properly adjusting the pressure, i.e. in the neighbourhood of 350 mm. W.G., the end gas only contains about 150 mm. H_2SO_4/cu.m. The acid mist not absorbed in the tower can also be precipitated in an electrofilter instead of in a ceramic pressure filter. The produced acid (10) is withdrawn from the acid cycle of the tower and cooled in a separate cooler (11).

Service requirements

The following data refer to consumption per metric ton of 60°Bé acid:

- Power - approximately 35-40 KwH
  Cooling water - at 20°C 20-25 cu.m.

At the same time there will be a steam bonus of 0.8 - 1 ton saturated steam at 22 atm.

Application

The Lurgi Wet catalysis process is in use at a number of coke oven works in Germany. These include the new coal gasification plant at Dorsten of Steinkohlengas A.G., a wholly owned subsidiary of Ruhrgas A.G., and also at the "Prosper" coke oven works at Bottrop, the latter, see picture, has a daily capacity of 40 tons 60°Be acid. The cost of sulphuric acid produced by the wet contact process compares favourably with acid produced at plants using other sulphurous raw materials.

NORWAY

Pyrites production, consumption and exports 1953

Production of pyrites which accounts for the largest share (over 40%) of the value of Norway's mineral output, exceeded in 1953 ¾ million tons, the highest level attained

since before the war. An important part of total pyrites output is in the form of high cupreous smelter pyrites, used for the production of sulphur and copper matte by Orkla Grube A.B. In 1953 production of smelter pyrites amounted to just over 300,000 metric tons, virtually the same as during 1952. Production of pyrites for sulphuric acid manufacture amounted to 457,229 metric tons, an increase of about 50,000 metric tons (12¼%) compared with 1952. This total was made up as follows:-

	1953	1952
	Metric tons	
Cupreous pyrites	143,324	105,127
Non-cupreous pyrites	154,494	131,162
Flotation pyrites	159,411	173,241
	457,229	409,530

The increase in total production is primarily attributable to the operations of Elektrokemisk A.S. at their Skorovas mine in the important Grong pyrites field. Production started in November, 1952, after difficulties in dressing the fine-grained Grong pyrites were overcome by pelletising the ore. The ore treatment plant, which is designed to yield 150,000 metric tons dressed ore, produced in 1953 88,355 metric tons cupreous and non-cupreous pyrites. Lack of markets have prevented its fuller employment, although it is considered doubtful whether the technical limitations will permit its achieving maximum rated output. Ore transport from plant to port, a distance of some 50 miles, is effected by aerial ropeway. As this was found to lack stability against high winds, some reconstruction took place in early 1953 and masts were spaced closer.

On completion of development work at the Gravdal mine production started in 1953, and total output amounted to 6,140 metric tons non-cupreous pyrites. Minor fluctuations[+] apart, the principal changes in output of other producers were a decrease of over 27,000 metric tons of Orkla cupreous pyrites, a decrease of over 16,000 tons in Killingdal pyrites, and an increase of 5,000 tons in Folldal pyrites.

[+] For full details see Statistical Appendix.

Domestic consumption of pyrites in 1953 amounted to about 73,000 tons, a decrease of about 20,000 tons compared with 1952. As domestic shipments in 1953 totalled 88,500 tons, consumer stockpiles rose by about 15,000 tons.

Of Norway's 13 pyrites producers, seven, including the largest Elektrokemisk A.B., supply their entire output to export markets. Exports in 1953 amounted to 321,380 tons which was 14,500 tons (4½%) less than in 1952. Nearly one-third of Norway's pyrites exports[+] are directed to Iron Curtain countries, notably East Germany. Compared with the previous year, 1953 exports to these destinations were about 19,000 tons lower. Among the exports to other destinations principal changes were a reduction of about 9,000 tons of exports to France and 8,000 tons to Belgium, and an increase of 18,000 tons to Western Germany and 5,000 tons to Holland.

A number of new pyrites developments have been reported, including the possible development of the Vesterdal field and the exploitation by Bolidens, the important Swedish concern, of a Norwegian pyrites deposit, subject to their reaching an agreement with the Norwegian Government.

CURRENT EVENTS

United Kingdom

Sulphur recovery at Anglo-Iranian Oil Company Grangemouth Refinery

The completion of the company's post-war expansion scheme at Grangemouth was achieved early in September, when the last three units - a 60,000 tons per annum catalytic polymerisation unit, a Girbotol plant for the extraction of hydrogen sulphide from the refinery gas stream, and a sulphur recovery unit - started operations. The Grangemouth refinery now has a crude oil capacity of 2.7 million tons per annum, or nearly eight times greater than immediately after the war.

[+] For full details see Statistical Appendix.

The sulphur recovery plant will initially produce 14 tons per day, i.e. about 5,000 tons per annum refined sulphur. This is expected to be of high purity and will accrue in the form of flakes to facilitate storage and subsequent transport. It is reported that the entire output is to be taken up by the Broxburn works of Scottish Oil Ltd. for sulphuric acid manufacture.

Sulphur recovery at Shell Oil Refinery, Stanlow

During the second week of September, the new sulphuric acid plant at the Stanlow oil refinery of the Shell Petroleum Company began operations. With this plant, and the sulphur recovery plant started in 1952, Stanlow is the only refinery in the United Kingdom which is self-sufficient for supplies of sulphur and sulphuric acid. The new acid plant, erected at a cost of £200,000, has an annual capacity of 33,000 tons (100% H_2SO_4) equivalent to about 11,500 tons sulphur. The capacity of the sulphur recovery plant is about 15,000 tons per annum sulphur, so this oil refinery is now in a position to contribute over 3% of the U.K.'s total requirements of sulphur in all forms. This does not take into account the considerable tonnage of sludge acid which is regenerated for subsequent reuse.

The sequence of sulphur recovery and consumption at Stanlow is shown in the following flow sheet.

The installation at Stanlow of a hydrogen desulphurisation plant which came on stream this year nearly doubled the amount of sulphur removed - in the form of hydrogen sulphide - in the course of oil refining operations. In this plant 85% - 90% of the sulphur present in straight run gas oil and catalytically cracked cycle oil which, if derived from Middle East crude, contain about 1.3% and 2.9% sulphur respectively, is removed by passing the oil in liquid phase together with hydrogen through a bed of cobalt-molybdenum-bauxite or tungsten-nickel-sulphide catalyst.

The capacity of the plant is stated to be 10,000 barrels per day, so that assuming equal quantities of respective oil fractions being treated about 10,000 tons sulphur per annum is obtained in recoverable form. Previously only catalytic cracking and reforming operations yielded hydrogen sulphide which, after extraction from the

mixed gas stream by the Girbotol (amine) process, was converted to 99.9% pure sulphur by the Claus process. The increased availability of hydrogen sulphide is now utilised in the new acid plant. Its sulphur requirements are met by burning hydrogen sulphide, together with some elemental sulphur to produce sulphur dioxide, which is converted in a conventional four-stage contact unit. Subsequent absorption by sulphur trioxide is effected in two towers which produce 98% H_2SO_4 and 20% oleum respectively.

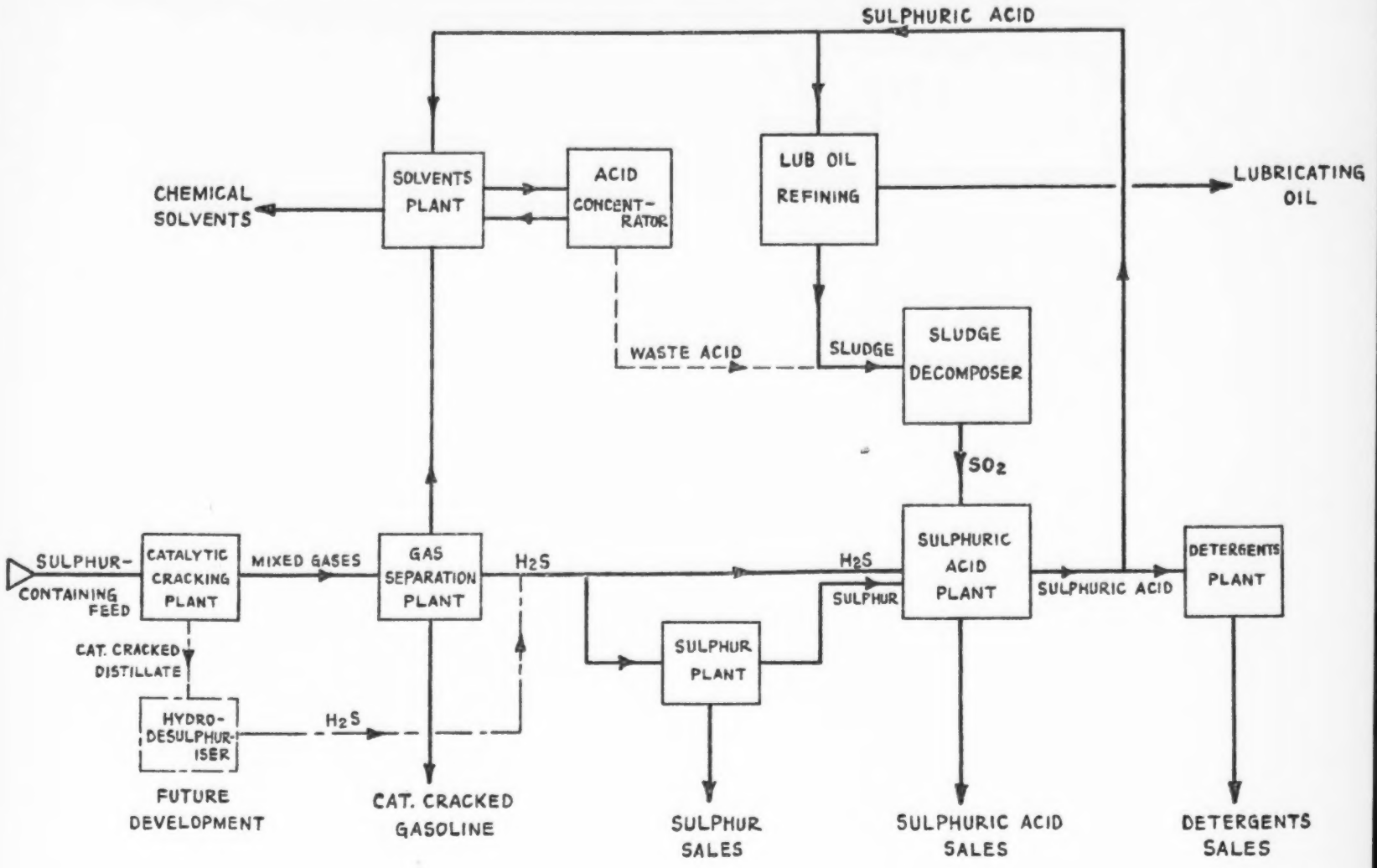
As shown on the flow sheet the acid system operates in a closed circuit whereby the tonnage of regenerated sludge acid is augmented by new acid to meet refinery requirements, leaving the surplus for outside disposal. Similarly, the tonnage of refined sulphur surplus to Stanlow's acid making requirements is sold, primarily to industrial consumers needing sulphur of high purity. In this connexion it will be recalled that in May of this year Shell Petroleum Company, Stanlow, pioneered the first transportation in the U.K. of sulphur in liquid form, which, in specially designed road tankers, is so delivered to the works of Messrs Brotherton at Bromborough, Cheshire, nine miles distant.

France

New sulphur prices

As from 1st September, 1954, the official sales price of sulphur in France was reduced by the Government by fr.5 to fr.15.50 per kg. Although supplies of sulphur to French consumers had consisted for some time past almost entirely of American sulphur imported at world prices, the prevailing costs of the Perequation account necessitated a higher internal price. These perequation charges included a contribution payable to the Societe Languedocienne de Recherches et d'Exploitations Minieres arising from the cessation of sulphur mining and production in summer 1953. The official price reduction followed the discharge of this indebtedness. The reduction of the crude sulphur price to world levels was immediately reflected in reduced refined sulphur prices, which now range from fr.2,666 per 100 kg. ex works for ground sulphur of 100 mesh, to fr.2,866 for 300 mesh, sulphur candles fr.2,910, and sublimed sulphur fr.3,027. These prices represent a reduction of about fr.600 on prices ruling before 1st September.

FLOW OF SULPHUR PRODUCTS. SHELL'S STANLOW REFINERY.



Recovered sulphur prospects

The exploitation of the extensive natural gas deposit at Lacq promises the recovery of substantial quantities of sulphur which will have to be removed in order to permit the utilisation of this gas by French industry. It is anticipated that, from 1956 onwards, an annual recovery of 40,000 tons sulphur will be effected, and it is foreseen that this tonnage could be substantially increased. In view of moderate production costs of recovered sulphur it is now most improbable that mining operations at the Malvezy sulphur deposit and ore refining by the Societe Languedocienne will be resumed.

Turkey

Potential sulphur recovery from oil

Recently pilot plant tests in connexion with the potential sulphur extraction from refinery gases were carried out at the new Batman oil refinery, which is to treat Raman crude oil containing about 3.5% - 4% sulphur. After separation of propane and butane the dry gas showed the following analysis and expected yields:-

Components	% by weight	Metric tons per year
Ethane and Ethenes	39.4	1,953
Methane	21.8	1,078
Hydrogen	2.0	97
Hydrogen sulphide	36.8	1,820
Total	100.0	4,948

The refinery is designed for a capacity of 350,000 tons crude oil per annum, and is to include vacuum distillation and thermal cracking (T.C.C. process) plants. It is being erected by Ralph M. Parsons Company of Los Angeles. In view of the comparatively small quantity so arising, and the unfavourable location - 450 miles from the nearest port - recovery of sulphur is not likely to be undertaken unless local use, preferably captive, can be found.

Israel

Fertilisers and Chemicals Ltd.

Since the commissioning of the company's new pyrites roasting and sulphuric acid plants in October, 1953, their output of acid and phosphatic fertiliser have increased significantly. By the end of July, 1954, over 32,000 tons sulphuric acid had been produced. Of this about 70% was captive, and consumed for the company's own superphosphate manufacture. This amounted to 7,700 tons in June, the total capacity of the plant having been raised to 300 tons per day. The balance of the company's sulphuric acid production is being exported to Cyprus and Turkey.

The latter exports are made under an agreement between the company and Gubre Fabrikalaritao of Sariseki, important fertiliser manufacturers in Turkey, who will receive 20,000 tons sulphuric acid in 1954, and 30,000 tons in 1955, on a barter basis. In return pyrites equivalent to this tonnage on the basis of 1¾ tons pyrites containing 48% - 50% sulphur to one ton monohydrate are being delivered, and by end July, 1954, a total of 35,470 tons pyrites had been imported. This is at present the only source of pyrites supply to Israel.

The new sulphuric acid plant has an annual capacity of 80,000 tons. Prior to its installation Fertilisers & Chemicals produced acid in a small brimstone burning plant with a capacity of 30 - 35 tons per day. This has since been modified and a sulphur trioxide line joining the two acid plants was installed, so that it is now possible to operate the old contact plant on gases arising in the pyrites roaster. The total acid making capacity now available is stated to be 100,000 tons per annum.

Exports apart, current acid output is principally consumed in the company's superphosphate manufacture, which is adequate fully to meet Israel's domestic requirements. For the current agricultural year these are estimated at 65,000 tons superphosphate, rising during coming years to 80,000 tons. By the end of this year the company is expected to commission a potassium sulphate and a phosphoric acid plant which are expected to take up the balance of the available sulphuric acid capacity. The only difficulty experienced

at present is the question of disposal of pyrites residues, of which some 13,000 tons have been accumulated. The company's share capital of IL 5½ million is being increased by IL 1 million, and the newly issued common stock will be sold mainly to the Israeli Government in order to secure the latter 50% of the voting power.

United States of America

Standard Sulphur Company

The results of the company's operations for the fiscal year ending 31st July, 1954, were recently presented by the President, Mr Gilbert B. Ebarb, Sr. Net earnings for the year amounted to $154,770.83 being the balance of an income of $1,048,395.95, of which 99% was derived from sales, and costs of $893,625.12, of which production and development costs accounted for over 71%.

In this connexion it is mentioned that actual production took place only during the last eight months of the fiscal year under review, and that construction continued even after the start of operations in November, 1953. Furthermore, revenue did not reach the company until after February, 1954, when sulphur shipments started. For a full year operating costs were calculated at $21.48 per ton, and the sulphur stocks of 10,483 tons at the end of July were carried at this figure.

The installation of increased capacity which will now amount to 120,000 tons per year, is expected to be in full operation by the end of September. In addition to some 6,000 tons produced in 1953, the company produced 43,000 tons during the first eight months of 1954. The entire output is exported.

Exploratory drilling is reported not only to have substantiated reserves+ in the immediate area of production, but to have increased the amount of proved sulphur reserves on the acreage which is at present being leased. In this connexion Mr Biel, the company's Sales Director, commented on the earlier activities on Damon Mound by Union Sulphur Company in 1924/26, and subsequent exploration by Jefferson Lake Sulphur Company as follows:-

+ 1.97 m. tons sulphur in an area of 150 acres.

"At about the time mentioned, this company (Union Sulphur Company) was granted a lease on Damon Mound, by the fee owners of the property, conditioned upon their erecting a plant of a definite capacity, insofar as the heating of water was concerned. When the plant was about three-quarters completed, the owners discovered that it did not have the capacity provided for in the lease and Union Sulphur Company would not agree to increasing the capacity to the amount contracted for. The owners, therefore, rescinded the lease and Union Sulphur Company dismantled the plant and removed from the property before any steaming operations had commenced.

"In the middle 1930's, Jefferson Lake Sulphur Company did some minor exploratory drilling on Damon Mound, none of which drilling took place on the 800 acre portion of the Mound leased to Standard Sulphur Company."

In his report to stockholders, the President stated that the acquisition of one or more prospective leases for sulphur were under consideration. Furthermore the company were examining the possibilities of diversifying operations into related fields, such as grinding and bagging crude sulphur, as well as furnishing a service for mixing ground sulphur with other ingredients for the fertiliser trade. The sulphur produced at Damon Mound is stated to be of excellent quality, bright and free from impurities. In export markets to date it has commanded a price of $33 per ton f.o.b. Gulf ports.

New dome exploration company

A new company to explore sulphur domes has recently been formed under the name of Sulphur Exploration Company of Houston, Texas. The company's first lease on which they have to date drilled five exploration wells covers the Hockley Dome in Harris County, near Houston. The company intends to prospect domes which have been previously explored, but on which there still remains a reasonable possibility of sulphur deposits remaining undiscovered. It is assumed that this may include domes which had been abandoned as unprofitable at a time of lower sulphur prices.

Texas Gulf Sulphur Company

This company has recently established an office at Palermo in Sicily. It is reported that Texas Gulf Sulphur Company has been taking an interest in contributing to the modernisation of Sicilian sulphur mines and the introduction of economic refining methods. In this connexion it is also reported that Texas Gulf Sulphur Company is developing an ore refining process which holds out promise of being efficient and economic in operation.

Apart from the company's interest in sulphur ores in Sicily, it is understood that contact has also been established with a number of ore property owners in Chile.

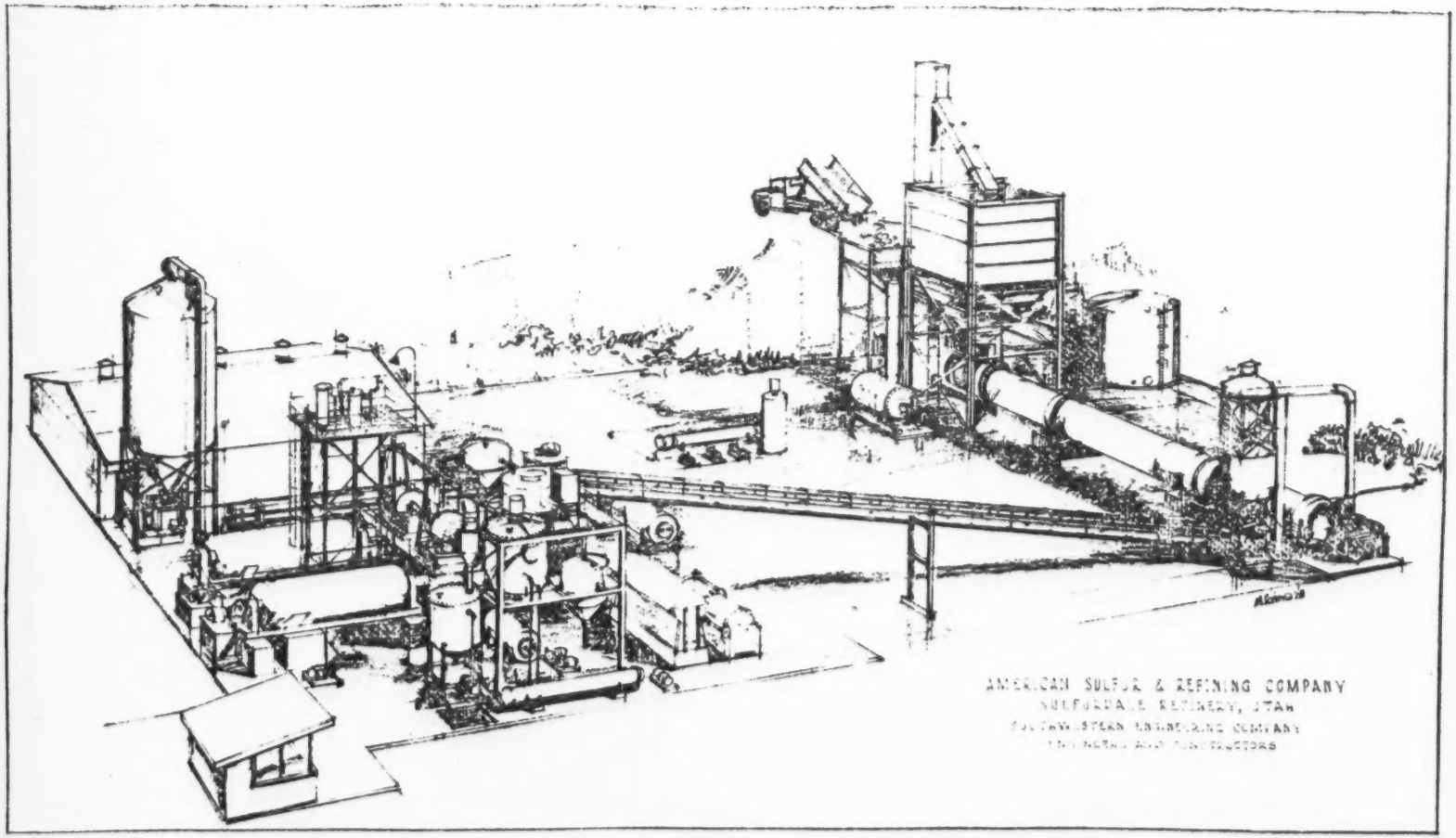
American Sulphur and Refining Company

This company which, for the past four years, has been developing sulphur recovery processes acquired in August exclusive rights for the Standard Oil Development Company's solvent process for the extraction of elemental sulphur in the U.S.A., as well as patents of this method in foreign countries.

This process, according to the company's Director of Sales, Mr Wm. N. Neale, is an important low cost method of extraction which will open up methods for profitable production at large surface deposits which have hitherto been unexploitable at ruling price levels. The company is at present constructing several plants for the solvent extraction of sulphur, which can treat sulphur bearing ores or materials containing 15% sulphur or more, and yield an end product of refined crystallised sulphur of minimum 99.5% purity free from arsenic, selenium and tellurium.

Of these the plant at Sulphurdale, Utah, which has been engineered by the Southwestern Engineering Company of Los Angeles is to start operation in December of this year, and produce 100 tons per day refined crystallised sulphur. Ore for this plant, which is shown opposite, will be extracted by open-cast method, and it is expected that it will show an average content of about 19.8% sulphur.

Cost of a refining plant of the above type is about £5 per ton year. Production costs of sulphur are stated to



AMERICAN SULFUR & REFINING COMPANY
SULFURDALE REFINERY, UTAH
[illegible] ENGINEERING COMPANY
ENGINEERS AND CONTRACTORS

be competitive with Frasch sulphur costs.

Details of the company's plants and refining processes are not as yet available. The company is interested in development and construction of refining plants throughout the world, and in this connexion the recent visit of the company's Chairman, Mr Wheeler, and Mr Neale to Peru and Chile are of particular interest. It is reported that the sulphur refining plants to be located at Arica, in Chile, and Ilo, in Peru, may use one of the company's processes.

Sulphur recovery from oil

The successful results obtained in the course of pilot plant operations by Hydro-Carbon Research Inc. at Trenton, New Jersey, hold out promise of substantially increased recovery possibilities of sulphur contained in oil.

With a view to utilising the heavy oil residues arising in the course of oil refining operations, the company has developed a process of destructive hydrogenation known as hydro-cracking. Treatment of the heavy residue with a specific gravity of 1.05, permits the production of 50% 90-octane petrol, 10% diesel oil, 25% gas, and 15% coke which is used to maintain the process reaction. Alteration of pressure and temperature conditions gives wide flexibility in the range of end products. In the course of the process a large proportion of the high sulphur content of the heavy residue is released in the form of hydrogen sulphide which is recoverable.

Mexico

Mexican Gulf Sulphur Company

Continued satisfactory output at the company's San Cristobal dome and the imminent completion of loading facilities at Puerto Mexico are expected to permit regular sulphur exports to start early in November. During the past months Mexican Gulf Sulphur Company have been engaged in building up a comprehensive export sales organisation. In this connexion they have appointed Messrs L. Lazarus of Creechurch House, Creechurd Lane, London, E.C.3, their agents for the sale of acid and "regular" sulphur in the U.K. It is understood that the company's President, Mr Paul

Nachtman, is about to set out on a goodwill tour of the principal sulphur importing countries. He is expected to visit U.K. and Europe during October.

Pan-American Sulphur Company

After a steaming period of several weeks production at the company's Jaltipan dome started on 28th September. Initial results are reported to give every indication that the original estimates of an annual production of 300,000 - 400,000 tons will be quickly reached. It is expected that export shipments may start before the end of the year, and the company envisage prices competitive with the major U.S. sulphur producers. It is understood that sales of acid sulphur will be directed by the company's head office at Dallas, Texas. For sales of "regular" sulphur, Messrs Guest Industrials Ltd. of 81 Gracechurch Street, London, E.C.3. have been appointed agents for the U.K.

Chile

It is reported that the Chilean Minister of Mines is examining the results of experiments conducted by Dr Francesco Roma of the Italian National Association for the Control of Fuels and of Bologna University, who claims to have developed a successful process for the low cost sulphur refining of ores. This process is reported to have been proved in pilot plant stage, where it has shown satisfactory results, even for low grade ores. The capital costs for plant are stated to be high, but as the process is claimed to permit recovery at low operating costs, of at least 90% of the sulphur content of the ores so treated, it is hoped it may provide a solution for the present inability of Chilean producers to enter world markets due to their high cost of production. In this connexion it was also announced that the Chilean Ministry of Mines estimates that indigenous reserves of sulphur ores that could be treated by this process amount to 400 million tons sulphur.

o o o O O O o o o

STATISTICAL APPENDIX

UNION OF SOUTH AFRICA

Production & Imports (000s short tons of 2,000 lb)

Year	Pyrites	S. cont.	Imports
1940/9 Av.	40.5	17.8	40.8
1950	45.1	19.4	75.3
1951	45.0	19.3	66.7
1952	42.5	18.1	81.3
1953	105.9	41.6	81.7
1954Jan-June	90.5	38.4	21.2Jan-April

NORWAY

Pyrites Production (000s metric tons) excl. smelter pyrites.

	Cupreous	Non-Cupreous	Flotation	Total 1953	Total 1952
Björkaasen	-	54.3	10.5	64.8	70.0
Folldal	-	-	39.1	39.1	34.2
Fosdalen	-	-	11.7	11.7	11.5
Gravdal	-	6.1	-	6.1	-
Killingdal	5.4	-	13.3	18.7	35.0
Nord-Norge	-	-	6.8	6.8	5.7
Orkla	67.2	-	-	67.2	94.5
Röros	-	-	1.9	1.9	3.9
Skorovas	68.5	19.8	-	88.3	6.2
Stordö	-	58.8	-	58.8	61.5
Sulitjelma	2.2	-	56.1	58.3	59.3
Undal	-	9.3	-	9.3	5.0
Vigsnes	-	6.2	20.0	26.2	22.7
	143.3	154.5	159.4	457.2	409.5

Pyrites exports (metric tons)

	1953	1952
Belgium	2,094	10,292
Czechoslovakia	22,160	27,354
Denmark	62,548	62,345
France	11,349	20,117
E. Germany	55,214	69,431
W. Germany	78,606	60,861
Netherlands	5,174	-
Poland	15,302	15,156
Sweden	68,933	70,316
Total	321,380	335,872

O.E.E.C.*

Production 1953 (000s metric tons sulphur)

	Native(x) & Recovered	Pyrites	In other forms	Total
Austria	-	-	61.1	61.1
Belgium	0.2	-	2.6	2.8
Denmark	-	-	1.6	1.6
Eire	-	-	0.6	0.6
France	11.1x	130.1	36.5	177.7
W. Germany	60.6	192.0	83.5	336.1
Greece	1.4x	110.0	13.3	124.7
Italy	223.1x	558.0	92.0	873.1
Netherlands	12.1	-	6.8	18.9
Norway	103.3	194.4	3.8	301.5
Portugal	16.9	299.3	-	316.2
Sweden	24.2	191.0	24.4	239.6
Switzerland	-	-	0.8	0.8
U.K.	26.1	2.9	384.8	413.8
	479.0	1677.7	711.8	2868.5

Consumption 1953 (000s metric tons sulphur)

	Elemental sulphur	Pyrites	In other forms	Total
Austria	22.1	34.2	53.4	109.7
Belgium	34.9	134.2	121.3	290.4
Denmark	-	62.5	0.2	62.7
Eire	0.2	26.0	0.6	26.8
France	110.5	332.3	74.9	517.7
W. Germany	63.3	620.0	139.6	822.9
Greece	12.8	18.6	10.5	41.9
Italy	82.0	508.4	79.2	669.6
Netherlands	3.2	174.7	18.2	196.1
Norway	28.6	34.7	11.1	74.4
Portugal	12.0	32.2	-	44.2
Sweden	56.0	229.0	-	285.0
Switzerland	22.6	28.0	0.2	50.8
U.K.	352.7	184.4	436.1+	973.2
	800.9	2419.2	945.3	4165.4

+ Including about 204,000 tons sulphur in anhydrite used in direct sulphate of ammonia manufacture.

* Collated from Report on Sulphurous Raw Materials position 1953.